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THE LARCH SAWFLY AS AN INDICATOR OF MOUSE ABUNDANCE[1]

BY SAMUEL A. GRAHAM

When we undertake to study the factors of environmental resistance that are operating to hold an insect in check we are very likely to find some unexpected things. Such has been the case in our study of the larch sawfly. Some of the environmental factors that promised to be most important in reducing the multiplication rate of this insect have proved to be relatively unimportant whereas others that were formerly thought to be of minor significance are proving to be of primary importance. One of these factors that was thought to be of minor importance is the effect of mice.

Many years ago Hewitt reported that mice dig up and eat the cocooned pre-pupae of the larch sawfly, but he regarded this activity as being rather abnormal for these animals and appears to have considered his observations as being interesting but of little real significance. The author has long suspected that mice are much more highly insectivorous than they are usually thought to be. This suspicion has been strengthened from time to time when some of his entomological experiments have been destroyed by these rodents. It has been found necessary to use the greatest precaution in protecting experimental insects from mice.

During the summer of 1927 a mouse found his way into a cage con-

[1] The data upon which this paper is based were collected in the course of cooperative investigations of the larch sawfly by the U. S. Bureau of Entomology, the University of Minnesota, and the University of Michigan. Mr. Leslie W. Orr was especially helpful in that portion of the field work conducted in Minnesota.

taining several hundred larch sawfly cocoons and destroyed the greater part of its contents. A study of the havoc resulting from this foray led to the work on which this paper is based. Examination of this cage after the damage had been done revealed two things. First, that the incisor marks around the opening made by mice in a cocoon served to distinguish cocoons opened by mice from those from which sawflies had emerged normally or those from which parasites had emerged. Regardless of the size of the opening, and some are very small, the incisor marks can be distinguished if a cocoon has been opened by a mouse. The second fact brought out was that a mouse in eating a larva discards all the skin and hard parts and consumes only the soft tissues of the insect. Thus insect food might not be evident when an examination of the stomach contents of the mouse is made.

Examination in the swamps showed that a very large proportion of sawfly cocoons in nature had not emerged normally but had been opened by mice. In a collection made near Itasca Park, Minnesota, out of 481 open cocoons of the larch sawfly 74, or 15 per cent, had emerged normally, 382 cocoons, or 80 per cent, had been opened by mice, 15 cocoons, or 3 per cent, had been parasitized by insects, and 10 cocoons, or 2 per cent, had been destroyed by fungi. Other collections showed a similar condition in many other swamps in and around Itasca Park, Minnesota. Later in the autumn of 1927 similar conditions were observed in Michigan, and since that time observations made in many different localities indicate that wherever the larch sawfly occurs mice are of much value in reducing the abundance of this insect.

During the season of 1928 random collections were made both in Minnesota and in Michigan that demonstrated more conclusively the importance of mice as destroyers of the larch sawfly. The data from these collections are summarized in table 1. The unopened cocoons, in the Minnesota collections, were placed in cages until the sawflies or parasites had emerged. This was not done with the Mud Lake, Michigan, collection. Therefore, in order to make the data comparable, the major portion of the cocoons recorded in the living column should be added to those under normal emergence as most of the unopened cocoons would have emerged normally if they had been given the opportunity.

It is interesting to note from the above table that the percentage of parasitism is very low both in Minnesota and Michigan whereas the percentage of cocoons opened by mice is in the neighborhood of 60 per cent. In making collections all cocoons found were retained.

Since the sawfly cocoons, as they lie buried in the moss, do not decompose for a number of years after they are spun the results of these collections represent averages over a series of years. It seems quite possible that variations in abundance of either mice or sawflies would result in annual fluctuations in the proportion of cocoons opened.

In addition to the random collection of cocoons discussed above, cocoons were collected in a uniform manner on sample plots in Mud Lake Swamp. Each sample plot was 66 feet square, thus making them $\frac{1}{10}$ acre in area. Along a line drawn diagonally across each plot ten

TABLE 1

Environmental resistance as indicated by random collections in 1928

LOCALITY	NUMBER COCOONS	NORMAL EMERGENCE		OPENED BY MICE		PARASITIZED		KILLED BY FUNGI		DEAD FROM UNKNOWN CAUSE		LIVING	
		Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Itasca Park, Minn.	796	197	25	516	65	33	4.0	19	2.3	28	3.5	3	0.2
	404	139	34.3	209	51.6	48	12.0	0	0	9	2.0	1	0.1
	382	186	48.6	173	45.4	17	4.5	3	0.8	2	0.5	1	0.2
	911	161	17.6	713	78.1	14	1.6	13	1.5	6	0.7	4	0.5
	1,020	442	43.2	512	50.2	31	3.0	3	0.3	29	2.8	3	0.3
Total	3,513	1,125	32.0	2,123	60.4	143	4.1	38	1.1	74	2.1	12	0.3
Mud Lake, Mich.	2,173	452		1,354		103		11				254	
	438	48		346		5		3				36	
Total	2,611	500	20.8	1,700	62.5	108	4.6	14	0.51			290	11.6

sub-plots were established at equal intervals. Each sub-plot was one foot square. From each of these plots all cocoons both old and new were collected and examined carefully. The results of this study are tabulated in tables 2 and 3.

The results of these systematic collections are very similar to those obtained in the random collections. In fact the results in 1928 are almost identical. This would seem to indicate that either method will give satisfaction if we collect a sufficiently large number of cocoons. The plot method does, however, have at least one distinct advantage over the random method. It shows not only the relative proportion of

mouse-opened cocoons, parasitized cocoons, and normal cocoons, but also indicates the degree of sawfly concentration at the point where the collections were made.

TABLE 2

Environmental resistance as indicated by plot studies in Mud Lake Swamp, Michigan, October, 1927

PLOT NUMBER	NUMBER OF COCOONS	NORMAL COCOONS ON SUB-PLOTS		COCOONS OPENED BY MICE		PARASITIZED		KILLED BY FUNGI	
		Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
1	18	9	50	1	6	3	16	5	28
2	79	32	40	39	49	8	11	0	0
3	37	15	40	18	49	2	5	2	5
4	136	28	21	96	70	4	3	8	6
5	119	50	42	59	49	8	7	2	2
6	47	2	4	39	83	6	13	0	0
Total.....	436	136		252		31		17	
Average per square foot..	7.3	2.3	31	4.2	57	0.5	7	0.3	4

TABLE 3

Environmental resistance as indicated by plot studies in Mud Lake Swamp, Michigan, October, 1928

PLOT NUMBER	NUMBER OF COCOONS	NORMAL COCOONS ON SUB-PLOTS		COCOONS OPENED BY MICE		PARASITIZED		KILLED BY FUNGI	
		Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
1a	155	43	27.8	104	67.1	8	5.1	0	0
2a	260	48	18.5	208	80.0	4	1.5	0	0
3a	501	211	42.0	264	52.8	26	5.2	0	0
1b	278	109	39.2	166	59.8	3	1.0	0	0
2b	288	68	23.6	215	74.8	5	1.6	0	0
1c	170	42	24.5	115	67.5	11	6.4	2	1.6
2c	256	54	21.2	191	74.5	9	3.5	2	1.8
Total.....	1,908	575		1,263		66		4	
Average per square foot..	26.5	8.2	30	18.04	66.3	0.94	3.5	0.05	0.2

From the data presented in tables 2 and 3 there appears to be no relation between the relative concentration of the sawfly on the plots and the proportion of cocoons opened by mice. From this it would appear that there is little or no tendency on the part of the mice to concentrate on those areas where the sawfly cocoons are most abundant. The local distribution of mice, then, must be regulated by some other factors than abundance of sawflies.

In general it appears that mice are most effective in destroying larch sawfly cocoons in places that are not very wet and where the ground is covered with moss or other loose material through which they can burrow easily. Under such conditions mice will find an abundance of food and shelter throughout the year and therefore it seems fair to assume that in such locations they will occur in their maximum abundance.

In dense sod or where the ground is excessively wet mice open a much smaller proportion of the sawfly cocoons. Such conditions offer the minimum opportunity for shelter and relatively little food. Therefore we may assume that under such conditions the mouse population will of necessity be sparse. It appears then that the proportion of cocoons opened by mice is an indication of the relative concentration of the mouse population.

MEASUREMENT OF MOUSE ABUNDANCE IN TERMS OF COCOONS OPENED BY THEM

The measurement of one phenomenon in terms of its effect upon another is an accepted principle in both physics and chemistry. We measure light in terms of its effect upon chemical activity or we measure temperature in terms of its effect upon some substance such as mercury. We have become so familiar with these methods that we think of temperature not in heat units but in terms of its effect on the mercury in our thermometer.

When, however, we attempt to measure biotic phenomena we practically always attempt to measure them in terms of the phenomena themselves. If we wish to measure the abundance of an insect we try to count the insects on a unit area or volume when we might just as well measure them in terms of their effect upon their food. Likewise if we wish to measure the abundance of mice we feel that it is necessary to count the individuals on unit areas when we might use other easier methods.

The observations of mice and the larch sawfly suggest the possibility

of measuring mouse abundance in terms of the effect of these animals on some food material. Such a method would be simple and would in no

TABLE 4

Effect of mice on larch sawfly cocoons planted on plots

PLOT NUMBER	COCOONS[2] PLANTED AUGUST 24, 1927								COCOONS[3] PLANTED AUGUST 30 AND SEPTEMBER 1, 1928			
	Examination November 4, 1927				Examination July and August, 1928				Examination October 13, 1928			
	Undisturbed		Open or gone		Undisturbed		Open or gone		Undisturbed		Open or gone	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
1									10	100	0	0
2	3	30	7	70	1	10	9	90	8	80	2	20
3	5	56	4	44	4	44	5	56	10	100	0	0
4									8	80	2	20
5	3	30	7	70	2	20	8	80	10	100	0	0
6	5	50	5	50	4	40	6	60	10	100	0	0
7	3	30	7	70	2	20	8	80	9	90	1	10
8	7	70	3	30	3	30	7	70	8	80	2	20
9	8	80	2	20	8	80	2	20	7	70	3	30
10									10	100	0	0
11									10	100	0	0
12	4	40	6	60	2	20	8	80	10	100	0	0
13	3	30	7	70	2	20	8	80	8	80	2	20
14					2	25	6	75	10	100	0	0
15	3	33	6	67	0	0	9	100	9	90	1	10
16	3	30	7	70	3	30	7	70	8	80	2	20
17	5	50	5	50	2	20	8	80	10	100	0	0
18					7	77	2	23	10	100	0	0
19									9	90	1	10
20					3	33	6	67	10	100	0	0
21									10	100	0	0
22									10	100	0	0
23									10	100	0	0
Totals....	52	44	66	56	45	31	99	69	214	93	16	7

[2] Each unit represents 5 cocoons.

[3] Each unit represents 3 cocoons.

way interfere with the animals. It could be used in places and under conditions where other methods would be impossible.

The collection of sawfly cocoons and the classification of these cocoons

in such a way as to show the proportion opened by mice is apparently one way of measuring mouse abundance. This method, as we have already pointed out, does not show the abundance of these animals from year to year but gives us only the average abundance for a series of years. In order to measure the relative abundance of mice from place to place at any given time it is necessary to use some other method.

With this end in view a series of experiments was started in 1927 and carried through 1928. The results from these experiments are summarized in table 4.

The purpose of the experiments was to measure the relative abundance of mice on a series of plots used in the study of the larch sawfly in Itasca Park, Minnesota. The method of procedure was as follows: Ten points were established and marked with stakes at regular intervals along a diagonal of each plot. Near each of these stakes was buried a cheese-cloth bag containing several larch sawfly cocoons. In 1927 five cocoons were placed in each bag, whereas in 1928 three were placed in each. Just previous to the closing in of winter and again in the following summer the cocoons planted in 1927 were examined. Those planted in 1928 were examined late in the fall and will again be examined next summer. The number of cocoons found is taken as an index of mouse abundance.

Table 4 shows that there is a considerable difference in the proportion of cocoons found by mice on the various plots. Some cocoons were found on every plot in 1927. The proportion was in general correlated with the availability on the plots of food and shelter for mice. On most of the plots mice were apparently doing very effective work in finding and destroying sawfly cocoons.

In 1928, however, a very different condition prevailed. On many plots none of the cocoons was disturbed, while on the others only 20 or 30 per cent of them were found. The reason for this difference was not difficult to find. During the season of 1927 the swamps in Minnesota were relatively dry so that dry nesting places were abundant. In 1928, however, as a result of a wet season, the water in the swamps was high, so that conditions were decidedly less favorable than in the previous summer. As a result the mice were forced to leave the swamp. Possibly many young may have been drowned in the nests. At any rate the effect of the mice on the sawfly cocoons was reduced as conditions became unfavorable for them. With one exception the percentage of cocoons found by mice was lower in 1928 than in 1927. The exception was plot 9. There was little evidence of mouse activity on this plot

either in 1927 or 1928. The plot is somewhat higher than the others and was affected very little by the high water. The scarcity of mice on this plot is probably explained by the scarcity of herbaceous vegetation, including moss, on the ground. As a result relatively little cover or food was available during either season.

From this experiment it appears that the relative abundance of mice as a group may be satisfactorily measured in terms of their effect upon some food material. Sawfly cocoons may not be the most desirable material to use, however. Perhaps some grain or wild seed might prove better. The principle, however, appears to be sound.

CONCLUSIONS

In the foregoing pages we have shown that one of the important factors of environmental resistance tending to hold down the numbers of the larch sawfly is the effect of mice. These animals open and destroy on the average about 60 per cent of the larvae that succeed in spinning cocoons. Comparable results were obtained by both random collecting of cocoons and by more systematic collections made on sample plots.

Cocoons opened by mice may easily be distinguished by the marks of the incisor teeth along the edge of the opening made in the cocoon. In eating a larva taken from a cocoon a mouse consumes only the soft internal parts, leaving the skin and hard parts. Therefore this type of food would not be evident in the stomach examinations.

The degree of effectiveness of mice in destroying sawfly cocoons appears to be a reliable measure of mouse abundance on an area. It is suggested that instead of the slow and difficult trapping methods of estimating mouse abundance that the abundance of these animals be measured in terms of their effect upon some standard food presented to them in a standard manner.

University of Michigan, Ann Arbor, Michigan.

SOME EXCESSIVELY LARGE LITTERS OF EGGS LIBERATED AT A SINGLE OVULATION IN MAMMALS

By Carl G. Hartman

[*Plate 15*]

Fishes and Amphibia discharge from a few to an enormous number of eggs. The entire spawn is deposited by the female at one time and usually fertilized in the water by the male.

Reptiles and birds lay larger eggs, well stocked with pabulum for the embryo until hatching takes place at a well advanced stage of development. Egg-laying reptiles lay their batches of eggs, one after another, in a short space of time, most species leaving them to their fate soon after their deposition. Birds, on the other hand, liberate the yolks singly with intervals of about a day between them. Each species of bird has a characteristic clutch number; but a given female may be made to lay a number of clutches in succession if one will persistently remove the eggs from the nest. The record for laying has, however, been reached by the domestic hen, which man has bred by selection into a laying machine that can produce four or five times its weight of eggs in a year.

To obtain data on the upper limts of fecundity in mammals has not been easy, especially data based on the number of eggs discharged at an ovulation. Perhaps the data do not exist, for little attention has been paid to the number taken from a given animal, the stage of development being considered the essential thing. More data are available on the number of young; but here again authors give little information other than averages. On account of the death of ova in utero or failure of fertilization, circumstances which vary from one individual to the other, the number of young born may be considerably fewer than the number of eggs discharged. In the four species in which the loss of ova has been studied, the rat (Long and Evans, 1922), the pig (Corner, 1923), the opossum (Hartman, 1919), and the mouse (MacDowell and Lord, 1926), the average loss is about one-third of all eggs shed.

A useful compilation on the length of gestation and the number of young in a litter is given by Jennison (1927). The arrangement is by orders and families. It is seen from the table that the great majority of mammals produce four or fewer young at a time. Among the more prolific species mentioned that are stated to run over ten are the following: arctic fox, 4 to 12; Gambian pouched rat, 6 to 12; muskrat, 6 to

12; hamster, 6 to 16; Tamworth pig, 15 to 20. It is clear, however, that the author has not taken cognizance of cases of unusual fecundity, but this is not to be expected from such a table.

Extreme cases that have come under my notice, including my own remarkable instances in the opossum, will be presented below, together with a discussion of an endocrine explanation of high fecundity.

For the pig, 24 young is the largest litter that I have seen mentioned. Thus Keller (1924) writes: "Das europäische Landschwein alter Type brachte Würfe von 12–18, und selbst bis 24 Jungen." Wentworth (1914) mentions a sow throwing 23 pigs in a litter. Brehm's "Tierleben" gives 20 as the limit of the sow. For the dog a litter of 15 or 16 young is considered exceptional, yet Comandlich (1904) published a case of 22. This figure is also the record for the rat; Keller cites litters of 22 for the Norwegian rat. A litter of 18 rabbits is the largest brought forth at the Bussey Institution, according to Dr. P. W. Gregory, a student of Castle. Doctor Gregory further tells me that he removed from one female rabbit 17 blastocysts of 144 hours' development. No other species of Eutherian mammal can compete with these figures, so far as I know.

Parenthetically, it may be of interest to consider what are the limits of fecundity in the human species. To quote that American classic on the biology of the human female, Williams' "Obstetrics," page 402, "According to Badouin, only five credible instances of sextuplet pregnancy have been recorded, and even several of them have been subjected to considerable criticism. On the whole, it may be said that reports of the birth of a greater number of children at a single labor are to be regarded as apocryphal, although many such are to be found in the older literature."

In point of fecundity, the higher mammals would seem to be entirely overshadowed by the marsupials, as shown by Hill's studies on the Australian dasyure (1911) and my own on the Virginia opossum (1919, 1925). Jennison (l.c.) gives 5 to 6 as the litter size for the former species, 12 for the latter. Let us see what the reproductive capacities really are in these species.

I quote first from Hill, p. 3: "One remarkable feature in the reproduction of *Dasyurus* is the fact that there is no correlation between the number of ova shed and the accommodation available in the pouch. The normal number of teats present in the latter is six, though the presence of one or two supernumerary teats is not uncommon; the number of ova shed at one period is, as a rule, far in excess of the teat number. I

have for example, several records of the occurrence of from twenty to twenty-five eggs, two of twenty-eight, one of thirty, and one of as many as thirty-five!"

The cases for the opossium are given in the following details:

Of the ten or twelve litters born in our opossum colony at the University of Texas, one of 18 and one of 21 pouch young were the largest. One litter of 23 normal full-term embryos was removed from the uteri (no. 448). Animal no. 675 furnished 19 eggs from one fallopian tube; the other tube containing eggs was preserved intact with the eggs. No. 545 yielded 16 eggs from one uterus, 11 from the other. But of the former batch 3 were "double-yolked," of the latter one was double-yolked. Hence the total number of eggs (vitelluses) ovulated in this case was 31. Other cases furnishing 30 or more eggs are listed in table 1.

TABLE 1

ANIMAL	NUMBER OF EGGS
140	30
112	33
149	33
121	36
36	39
352	39
346	43
743	43
58	44
109	45
838	56

The last mentioned animal of the table had been studied relative to the oestrous cycle from January 20 to April 1, 1922, when she was found to be pregnant. Thirty-six bilaminar blastocysts and twenty unfertilized eggs were removed from the uteri, a total of 56 eggs, 26 from one uterus, 30 from the other. Figure 2, plate 15, shows 54 of the eggs intact, two vesicles having collapsed. They were photographed after storage for five years in 80 per cent alcohol. The formative areas are well seen.

One other case (no. 972) deserves notice here; it has already been described in another connection (Hartman, 1927). The left ovary contained more than 18 corpora lutea, as the sections showed, though unfortunately the exact number could not be determined as some of the

sections were missing. Four eggs only were recovered from the corresponding uterus. The corpora lutea were genuine structures and not false corpora lutea with retained eggs. The right ovary contained more than 38 corpora lutea (34 may be seen in a single section through the organ). Thirty-eight eggs were recovered from the right uterus; these are shown in figure 1. Hence it is obvious that at least 60 eggs were discharged at one ovulation. It should be said, however, that neither uterus nor ovaries were normal, which may be connected with the cause of the superovulation (P. E. Smith) as set forth below.

Since the number of eggs laid by egg-laying animals and the number of eggs shed by mammals is constant within rather wide limits for a given species of animal, it is apparent that there is an internal control, probably endocrine, of litter size. In attempting to explain this control there are certain facts that must be borne in mind.

In the first place, fertility is independent of the number of oöcytes contained in the ovary, as first shown by Pearl (1912) for the hen. Certainly all female mammals are provided with an excess of oöcytes far beyond the reproductive needs of the individual during her reproductive period. There may be a rough correlation between the number of oöcytes in the ovary and fecundity of the individual (Hartman, 1926), but the relation is not that of cause and effect.

The second set of facts relates to the effect of unilateral ovariectomy upon litter size. It has been known since Hunter (1792) that after removal of one ovary the litter derived from the other is likely to be as large as the normal litter from both ovaries. This has again been shown recently (Asdell, 1924; Slonaker, 1927). In a series of experiments on the opossum (Hartman, 1925) the surviving ovary was found to deliver even a larger litter than the intact normal pair combined. Lipschütz (1927) has termed this phenomenon the "law of follicular constancy." To explain the phenomenon Hammond (1925, p. 78) invokes the hypothetical "generative ferment" of Heape, and supposes this to be a substance of unknown source circulating in the blood in definite amounts and carried to the ovaries, which are stimulated to a degree proportionate to the strength of the "generative ferment." Thus a single ovary would absorb the total amount intended in the species for both and respond with double the normal intensity. I have suggested that unilateral castration might be used with success in the case of sterile women whose ovarian activity falls just short of ovulation (1926).

The theory of the generative ferment was a good guess; but it remained for P. E. Smith and associates to determine the source and

manner of action of the hypothetical substance, a discovery corroborated by Zondek and Aschheim (1927) working independently. Thus, with rats, the implantation of anterior hypophyseal substance either of the same or any other mammalian species into an infantile female will cause sudden and extensive ripening of graafian follicles with consequent general reproductive maturity of the female. Smith and Engle (1927) produced what they call "superovulation" in a 22-day old mouse; 48 ova were found in one tube (against a normal maximum of seven) after only three daily implants of rat anterior pituitary. More than 60 eggs were liberated in several cases. Engle (1927) even secured a pregnancy with the unprecedentedly large number of 19–20 implanted embryos of the tenth day in one of the experimental animals.

It appears, therefore, that the hypophysis is the true "motor" of the ovary (Zondek and Ascheim). Its action on the genital tract is not direct but only through the ovary, which it stimulates into action.

An interesting fact in this connection is the correlation which seems to exist between fertility and size of breed in rabbits; for I am told by Doctor Gregory that "there appears to be in the rabbit a high correlation between the size of the female and the number of eggs ovulated. The Polish rabbit (weight 1500 grams) sheds on the average about three eggs at an ovulation. The giant strain (weight 8000 grams) sheds about ten eggs, while the intermediate sizes fall between these extremes in ovulation capacity." The coincidence here consists of the double function of the anterior pituitary; that of stimulating bone growth and that of stimulating reproductive activity.

By way of summary: The female mammal is born with tens of thousands of eggs in the ovary in excess of the reproductive needs of the species; yet the number that are destined to ripen and become discharged into the oviduct for fertilization is regulated within rather definite limits by the "internal milieu." The number can be greatly increased by anterior hypophyseal hormone introduced by the method of implantation. Hence we must look to the hypophysis as playing an important rôle in this control. In this paper some cases of spontaneous, abnormally large ovulation litters are presented and the above mentioned explanation cited.

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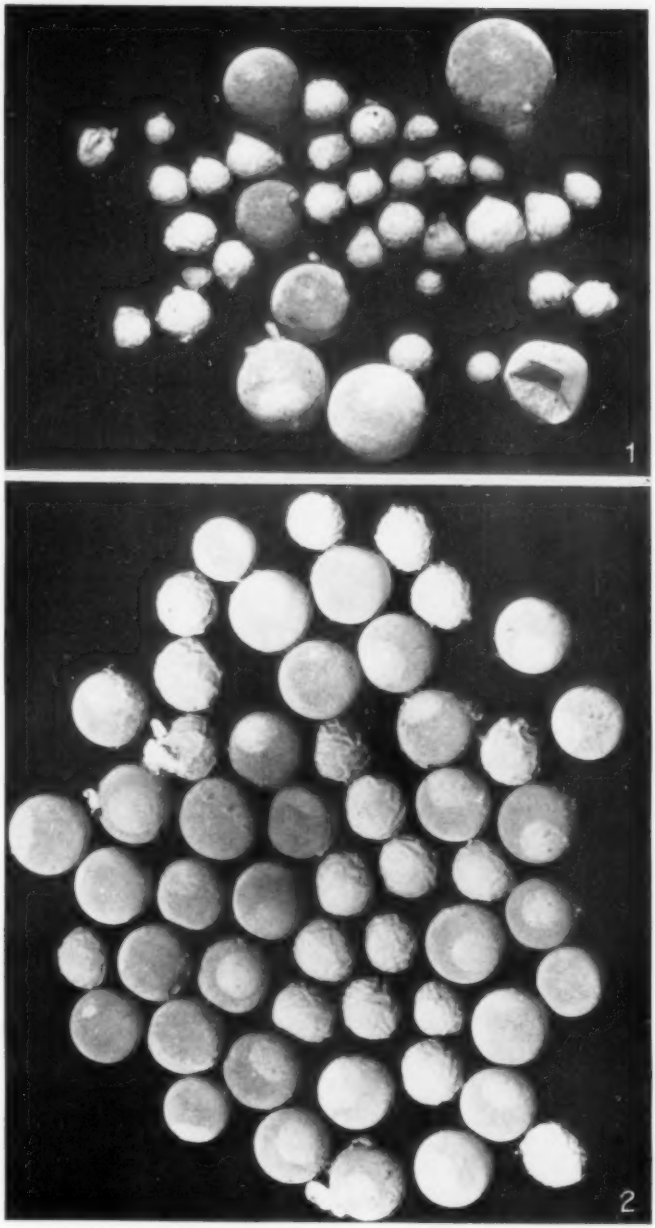

Opossum Eggs. 14×

BATS OF INDIAN KEY, TAMPA BAY, FLORIDA

By William G. Fargo

Indian Key, also called Bird Key, off the north shore of Tampa Bay, Florida, is less than a half-mile in length and lies about 1,000 feet from the bay shore near Maximo Point and some four miles from the Gulf of Mexico. This is a low-lying swampy key well covered with a dense growth of black mangrove (*Avicennia nitida*). The water is shoal in all directions from the key and for some distance.

Indian Key is a federal bird reservation, therefore I was taken there on January 25, 1928, by the warden in charge of the Tampa Bay Refuges, H. P. Bennett, who resides at Maximo Point. Mr. Bennett had assisted Dr. Manton Copeland in collecting bats on this key in the spring of 1925, at which time the dormant bats were found congregated in large numbers in hollow trees, as many as one hundred and fifty bats being taken from a single tree. Hence, we first searched for the bats in the larger dead hollow mangroves. Many of these old dead trees were blown down in the great storm of September 18, 1926. Mr. Bennett thinks that these larger dead mangroves were killed by the freeze of 1886, and that consequently, although the heartwood of this tree is very hard and dense, there are very few of these old stubs 12 to 18 inches in diameter or larger now standing. The greater number of the present live mangroves are not over 6 to 8 inches in diameter and 15 to 20 feet high.

Although a thorough search was made by us no bats were found in the larger hollow trees. Practically all the bats we saw on that day, some eighty-five in all, were found in narrow crevices or clefts, mostly between the partly decayed outer sapwood and the sound heartwood. These flat crevices containing bats were generally only $\frac{5}{16}$ to $\frac{3}{8}$ inches wide. Usually two to six bats were in a crevice; the largest number was fifteen.

Until our visit of January 25, 1928, Mr. Bennett had observed no rats on this key. On this visit we found rather numerous nests of the common roof rat of the south, *Rattus alexandrinus*. Two of the nests in 6-inch to 10-inch diameter hollow mangroves, within four feet of the ground, contained four to six apparently adult roof rats. The nests were all composed of mangrove leaves and bird feathers, with no grass. This rat is largely arboreal and when the hollow trees were tapped on near the nest, the rats emerged from some opening 8 or 10 feet above ground, and scampered off along small branches and twigs, leaping to

the nearest branches of adjacent trees as nimbly as would squirrels. It is possible that the rats came to the key on driftwood during the storm of September, 1926.

Of sixty-five bats examined on Bird Key, January 25, 1928, forty-four were *Myotis*, probably all *Myotis austroriparius* Rhoads (Proc. Acad. Nat. Sci. Philadelphia, May, 1897, p. 227), the type from Tarpon Springs, Florida. Gerrit S. Miller placed the name in synonymy (North Amer. Fauna no. 13, p. 63, 1897) but recently, after studying Copeland's specimens, he has revised his opinion and admitted *austroriparius* as a full species (Bull. U. S. Nat. Mus. 144, pp. 76–79, May, 1928).

Out of the forty-four *Myotis*, twenty-four were examined by me as to sex, six only being males.

Twelve bats taken on January 25 were Le Conte's free-tailed bat, *Nyctinomous cynocephalus* Le Conte. Ten of these were examined as to sex, only one being a male. The free-tailed bat has a strong but not unpleasant musky odor, which is very persistent in the collecting bags and also rather penetrating, so that it may be detected some feet away.

Eight specimens of Rafinesque's bat, *Nycticeius humeralis* Raf., were taken, four being males and four females.

Skins and alcoholic preparations of all three species of these bats were sent to the Biological Survey at Washington and identified there as the species stated above. All the bats skinned by me were in good flesh, some were quite fat, especially the males. All but a few of the dormant bats felt warm to the touch and, though sluggish or sleepy when disturbed, soon became active enough to fly, usually within a minute or two from the time when first disturbed. On the day the bats were taken the atmospheric temperature in the middle of the day was about 70°F.

All of the bats collected were handled with our bare hands and by exercising a little care we suffered no bites. With non-dormant bats, particularly the larger species, perhaps this would not have been so easy.

Mr. Bennett and the writer both believe that the reduction in numbers of bats on Bird Key in the past few years is probably due to the roof rats or a similar enemy. Since 1924 the writer has visited Bird Key several times each year and never has seen barn owls on the key although he has seen this owl on other keys a few miles away. On Bird Key no mosquitoes are seen in the months of January to May, inclusive, when our visits have been made, but on neighboring keys where bats are not found or if they exist it is in small numbers, the mosquitoes are

numerous in these months. There is no lack of breeding places for mosquitoes on Bird Key. Possibly the amount of free ammonia from the guano has something to do with the scarcity of mosquitoes.

On February 17, 1928, in company with Mr. Bennett, the writer visited Tarpon Key (also called Bush Key), another protected key lying two miles south of Bird Key and from which the next nearest key is about one and a half miles to the west. A thorough search was made of the possible hiding places for bats over two-thirds of the area of this key without finding any signs of them.

Several nests of rats in hollow mangroves, low down, were composed of grass, and three of the rice rats taken were identified by the Biological Survey as the Central Florida rice rat, *Oryzomys palustris natator* Chapman.

In this rat colony, a barn owl was flushed from its roosting place in a hollow mangrove stub, eight feet above the ground. This cavity contained some two quarts of pellets and bones, all of the skulls apparently being of this same rice rat. This key is less than a foot above mean high tide, and, therefore, is not well adapted as a habitat of mammals. Besides the rice rats no other mammals were observed. Hence, it is likely that the owl for a long time had subsisted principally upon these rats and thus prevented their material increase.

Jackson, Michigan.

EVIDENCE ON THE GESTATION PERIOD OF MARTENS

By Ernest P. Walker

[*Plate 16*]

In addition to the evidence that martens breed some time during the summer and bear their young the following spring, as first reported by Nelson[1] and by Ashbrook and Hanson[2], the following confirmatory instances are cited from Alaska:

Instance 1. During October, 1921, C. E. Swanson, a fox farmer and rancher located at Point Agassiz near Petersburg, Alaska, obtained from a neighbor a female marten which had recently been captured. Swanson kept this animal the winter of 1921–22 in solitary confinement in a small wire cage. About the last week of March, 1922, she gave birth to a litter of three or four young. This was a gestation period of at least six months.

Instance 2. In September, 1923, the Goldstein Glacier Fur Farm, Inc., of Juneau, Alaska, obtained three martens captured by trappers from the wild state shortly before. In October these three animals were placed in the care of Charles Rudy on his homestead near Juneau. The animals were kept in separate cages with four inches space between the double-walled wire compartments of adjacent cages. One of the females gave birth to three young on April 28, 1924. Mr. Rudy, who had sole charge of the animals, states that this female had no opportunity for contact with any other animal during the time she was in his charge from October, 1923, to April, 1924. This was at least a seven-month gestation period.

Instance 3. Archie P. McLean, a fur farmer of Kasilof, says that one of his martens mated in July and gave birth to young about the middle of the following April. This indicates quite conclusively a gestation period of about nine months.

Instance 4. Mr. Glass, who was caretaker on the Goldstein Glacier Fur Farm for a period, states that he saw a pair of martens at the farm mate on July 4, 1926.

Instance 5. George Jorgenson, of Juneau, remarks that on the fifteenth of July, 1926, a pair of martens he had in captivity was ob-

[1] Annual Rep. Chief Bureau of Biological Survey for the year ending June 30, 1922, by E. W. Nelson.

[2] Breeding Marten in Captivity, Frank G. Ashbrook and Karl B. Hanson, Journ. Heredity, vol. 18, no. 11, November, 1927.

served to be exceptionally playful and friendly with each other. This continued until early August then ceased.

Mr. Jorgenson also says that during the summer of 1926 he had five male martens in captivity and about July 20 he observed that the testes of all were enlarged to such an extent that they dragged upon the ground, and the lower portion of the scrotum was almost entirely bare of hair. This condition lasted until about the middle of August, then gradually returned to normal. He states it is possible that the condition may have existed a few days before July 20 without attracting his attention.

Instance 6. The caretakers at the Goldstein Glacier Fur Farm tell us that during the latter portion of May, June, and possibly early in July they noted the testes of the males had become much enlarged, and they observed a number of attempts to mate.

Instance 7. Dee Johnson, of Port Graham, saw a pair of martens he had in captivity trying to mate on June 7 and again on June 9. The female was apparently not in a receptive mood on either of these occasions but obviously nearly so.

Instance 8. Charles Rudy states that he has repeatedly observed that martens are exceptionally playful in late June and July.

Instance 9. Dee Johnson reports having captured a female marten from the wild state on February 27, 1924. This animal gave birth to young on April 4, 1924.

Instance 10. Mr. Johnson states that another female marten captured February 27 from the wild state died about a month later. Examination showed this animal pregnant.

Instance 11. Archie P. McLean says that one winter he caught a female marten which gave birth to two young on April 14. Both young were raised.

There are a few additional reports of martens giving birth to young in the spring after having been in solitary confinement for considerable periods. These reports, however, are so indefinite or unreliable that it does not seem advisable to record them.

The above instances, however, supply definite information that martens give birth to their young in the latter portion of March or early in April, and no evidence is at hand of their having young at other times of the year. We have definite evidence of different females having carried young for from five to nine months and we have evidence of martens being sexually active in May, June, and possibly July; also we have knowledge of martens having mated and others having attempted to

of age, and possibly do not breed every year, and that their litters are ordinarily only three or four, is of importance not only to those proposing to raise martens, but also to the wild life administrator, for it in some degree enables us to account for the exceedingly slow rate of upbuilding of the stock when once it has been reduced. These fragments of information indicate that great pains should be taken to prevent the marten stock from becoming seriously depleted, for this means a long period before it can be restored to proper numbers.

Unfortunately the marten is among the easiest of animals to trap in the wild. In order to maintain a supply it is necessary that the laws for their protection be properly restrictive and rigidly enforced.

U. S. Biological Survey, Washington, D. C.

OBSERVATIONS ON REPRODUCTION IN THE WHITE-TAILED PRAIRIE-DOG (CYNOMYS LEUCURUS)[1]

By A. H. Stockard

During the springs of 1925, 1927 and 1928, collections of prairie-dogs (*Cynomys leucurus*) and embryos were made by the author in the vicinity of Laramie, Wyoming. The animals were used as material for the study of the embryology and related subjects. The development through the early stages was worked out in 1926 and 1927, and studies on other phases of the problem are now in progress.

The animals were obtained by shooting from a car with a small shotgun and securing them before they could recover from the temporary paralysis caused by the shot, and kick themselves into their burrows in their death struggles. The animals thus procured were dissected immediately in the field or immediately upon my return to the laboratory, and record sheets were filled out as the dissections were made. Approximately 350 animals were taken and examined in this manner. Accurate records were kept, however, on only 248.

Whether copulation had occurred was determined by the condition of the vaginal membrane, correlated with the appearance of the uterus. The membrane is ruptured in pregnant females and intact in non-pregnant females, or females in which the uterus shows no congestion. Its rupture, therefore, is assumed to be due to copulation. One week

[1] Contribution from the Zoological Laboratory of the University of Michigan.

after copulation, pregnancy can be unmistakably determined by the presence of nodes in the uterus.

Copulations were first observed to have taken place on March 26, 1925, April 5, 1927, and April 1, 1928. Copulation was observed in one instance, on March 26, 1925. On April 2, 1927, several males were observed pursuing females. Eleven animals, all males, were taken on this date, consequently no pregnancies were recorded. Four females taken on March 30, 1927, however, showed no signs of pregnancy, though one of them appeared to be in heat.

The male reproductive system is apparently capable of functioning only through a brief breeding season. As is indicated in table 1, the males apparently break hibernation some two weeks in advance of the females, and from their first appearance above ground in the spring, the testes are very large, averaging approximately five grams a pair, and are usually located in the scrotum. The seminal vesicles and Cowper's glands are also very large, appearing equal in volume to the testes. The "corpora spongiosa" are enormously swollen, ranging in weight from 3 to 10 grams a pair. The glands from animals taken just before the beginning of the copulation period are somewhat larger than those taken earlier. The entire glandular system of males taken on April 9, 1927, and April 1, 1928, showed reductions to not more than one-tenth the size of those taken one week earlier in each season. The glands of only a few males taken later were enlarged and none with enlarged glands was taken after two weeks following these dates. I have made no observations indicating a second period of glandular activity during the year. This suggests that the breeding season may be limited in part on account of the short time during which the male system is functional.

The length of the gestation period has not been accurately determined. In 1925 the first pregnancies were observed on March 26; and on April 25, thirty days later, the first parturition observed for the season had taken place in one out of eight females taken. In 1927 the first pregnancies were observed on April 5, though rutting was observed on April 2; and parturition had occurred in two out of four females taken on May 7, thirty-two days after the first pregnancies were observed. In 1928 pregnancies were first recorded on April 1, though only one female had been taken before that date. Parturition had occurred in two out of eight pregnant females taken on April 22, two out of seven taken on April 27, and three out of five taken on May 1. The entire collection of nine females taken on May 8 had parturiated. On April 27 a female, which had been captured pregnant on April 1, gave birth

TABLE 1

Times of appearance, breeding and parturition in Cynomys leucurus

DATE	NUMBER ANIMALS TAKEN	NUMBER MALES	NUMBER FEMALES	NUMBER PREGNANT	NUMBER PARTURIATED
Record for 1927					
3- 8-27	2	2	0	0	0
3-14-27	4	4	0	0	0
3-24-27	1	1	0	0	0
3-27-27	3	2	1	0	0
3-30-27	5	1	4	0	0
4- 2-27	11	11	0	0	0
4- 5-27	12	2	10	9	0
4- 9-27	12	7	5	4	0
4-19-27	2	2	0	0	0
4-23-27	3	0	3	2	0
4-25-27	5	1	4	3	0
4-30-27	8	6	2	2	0
5- 7-27	24	12	12	8	8
Record for 1928					
3-30-28	1	1	0	0	0
3-21-28	3	3	0	0	0
3-23-28	1	1	0	0	0
3-24-28	2	2	0	0	0
3-27-28	2	1	1	0	0
3-31-28	4	4	0	0	0
4- 1-28	10	5	5	5	0
4- 2-28	1	0	1	1	0
4- 4-28	12	0	12	12	0
4-10-28	11	3	8	8	0
4-14-28	16	5	11	10	0
4-17-28	12	4	8	8	0
4-20-28	7	3	4	3	0
4-22-28	9	0	9	8	1
4-27-28	10	3	7	7	2
5- 1-28	9	3	6	5	3
5- 8-28	12	3	9	9	9
5-12-28	9	3	6	3	3
5-19-28	7	4	3	3	3

(Table does not include all males taken during 1928, as only representatives of each lot taken were desired for study of the sexual cycle in the males.)

to four young in the laboratory. Hence the period of gestation is probably between 27 and 33 days. See table 1.

Records from 66 pregnant females give the results shown in table 2 regarding the number and distribution of embryos in the uterus. Only such females are included in the records as are far enough advanced in pregnancy to make accurate counting of the number of nodes containing embryos possible. Comparison of this table with reports, published in the JOURNAL OF MAMMALOGY of February, 1927, by E. C. Cates, of May, 1927, by George E. Johnson, and of May, 1928, by Otis

TABLE 2

Number and distribution of embryos in 67 pregnant uteri of Cynomys leucurus

	NUMBER OF EMBRYOS IN EACH GROUP RECORDED											TOTAL	AVERAGE
	0	1	2	3	4	5	6	7	8	9	10		
Number of groups in right horns	0	8	18	15	23	3	0	0	0	0	0	196	2.93
Number of groups in left horns	5	8	18	22	11	1	2	0	0	0	0	171	2.55
Number of groups in complete uteri	0	0	2	0	11	21	20	12	0	0	1	367	5.48

Wade, of similar observations on the related species *Cynomys ludovicianus*, indicate that the average number of young in each litter produced by the two species is approximately the same, and that the period of gestation may be the same. The breeding season of *C. leucurus*, however, is later in Wyoming than that of *C. ludovicianus* in Oklahoma and Kansas and probably in Montana. This is to be expected in correlation with the higher altitude distribution of the former species and the consequent later appearance of the spring season over its range.

University of Michigan, Ann Arbor, Michigan.

NOTES ON THE BURROWING HABITS OF PEROMYSCUS POLIONOTUS

By F. B. Sumner and J. J. Karol

[*Plate 17*]

Howell[1] has given a brief account of the burrows of the "oldfield mouse," *Peromyscus polionotus polionotus* and the related subspecies *albifrons*, as observed by him in Alabama. The present writers were engaged for two months during the fall of 1927, in trapping these two subspecies in northwestern Florida and southeastern Alabama. Nearly five hundred specimens of the two forms were trapped during this period. With comparatively few exceptions, these mice were living when captured, and were sent to the Scripps Institution for use in genetic studies to be continued there.

Since it was necessary for us to trap at a considerable number of stations, and to collect rather large samples of these mouse populations within a quite limited period, little time could be spared for observations of the habits and precise ecological relations of the animals. But such as were made seem worth recording.

To begin with, it is interesting to note that most of the farmers of this region appear to be quite familiar with these mice and their ways. But as a rule they do not call them *mice* but *rats*—"little old field rats," in the quaint vernacular of the rural southerner. Indeed, we derived considerable amusement from the monotonous uniformity of the narrative which they volunteered when once the subject was broached to them. This was particularly true of their account of the trick of driving the mice out of the holes with a "switch." To what extent this information has been independently acquired, and to what extent it has been passed along as a part of the folklore of the region, is a question which we can not answer. The standardized narrative, which we heard recited by many different persons, suggests the latter alternative. However that may be, some of the more intelligent of the farmers were undoubtedly well acquainted with the ways of *Peromyscus polionotus* from personal experience, and were in a position to give us invaluable assistance in locating favorable trapping fields and even, in some cases, in securing specimens for us. This familiarity is not surprising in view

[1] A Biological Survey of Alabama. North American Fauna, no. 45, U. S. Dept. Agriculture. Washington, 1921.

of the considerable amount of damage which these little animals may do by digging up freshly planted seeds.

These mice were found by us in greatest abundance in fields devoted to some leguminous crop, as peanuts, velvet beans or "field peas." Some very successful catches were likewise made among watermelons, the seeds of which appear to be a favorite article of diet. Such crops, in the territory visited, are usually planted in rows, alternating with corn or, in certain localities, with Satsuma oranges. Fields were most favorable in which the sandy soil of the region was largely exposed to view. A dense growth of weeds was usually an unfavorable indication.

Before traps were set at any of our stations, a prospecting trip was commonly necessary. The chief *polionotus* "sign" consisted of the burrows and their accompanying mounds of earth. Usually (though not always!) a large catch could safely be predicted from the presence of numerous fresh burrows. Conversely, we may say that usually (though again not always) a very scanty catch could be predicted in cases where few or no burrows were seen. In any case, it is probably of little advantage to set one's traps close to burrows, rather than in the general neighborhood of these.

The diameter of the burrows, at the mouth, varies from an inch to an inch and a half, being slightly wider in a transverse direction. In most cases, they are left open, but in other cases, as Howell notes, they may be partially plugged with earth. There seems to be little ground for the statement, which we heard more than once, that an open hole indicates the absence of the owner.

Howell comments on the surprisingly large size of the mound which is sometimes thrown up by this very small species of mouse. Indeed, at a distance, it may sometimes be mistaken for that of the pocket-gopher (the "salamander" of the south). By inspection, however, it is always distinguishable from the latter by the nature of the aperture and the position of the mound on one side of this. The mound varies greatly in size, depending upon the age of the tenant and the depth to which the hole has been carried. At times it doubtless contains several large cupfuls of soil. When the excavation has been extensive, the soil of the mound frequently differs in color from that of the surrounding ground, because of the reddish color of the subsoil in much of this territory.

Several burrows which were excavated by us reached a depth of nearly or quite a foot. The hole first descends very obliquely to an enlarged chamber containing a nest and sometimes food. From this

FIGS. 1 AND 2. TWO BURROWS OF PEROMYSCUS POLIONOTUS ALBIFRONS, IN A SATSUMA ORANGE ORCHARD, IN THE VICINITY OF ROUND LAKE, JACKSON COUNTY, FLORIDA

chamber another tunnel leads obliquely upward nearly to the surface. This is generally credited with being an emergency exit, our informants sometimes adding that the mouse provides this means of escape in case its burrow is entered by a snake. Such an explanation of the utility of this ascending tunnel does not seem improbable. In the case of one burrow, which was measured roughly, the entrance and exit were about three feet apart, in another about five feet.

The traditional way of driving the mouse from its burrow is to prepare a pliant switch by stripping the leaves from some slender-stemmed weed, and to insert this into the mouth of the burrow. The switch is moved about until the end finds its way into the "escape" tunnel, and *presto*, the mouse "pops out" of the exit hole. Several persons who assured us of the ease of this procedure attempted a demonstration without success. But we have no doubt that it is possible to catch these mice in this way, though we regard trapping with suitable live-traps as a much more practicable method. One of the present writers dislodged two juvenile *polionotus* from one burrow by the "switch" method, after making the attempt vainly in numerous other cases.

Concerning the nature of the emergency exit, we are not altogether certain. We could not discover whether an actual second orifice is made by the mouse, and then plugged up with sand, or whether the ascending tunnel is carried nearly to the surface, and the thin remaining partition only dug through in case of pursuit by an enemy.

So far as our observations go, the type of burrow is the same for *P. p. polionotus* and *P. p. albifrons*. Figures 1 and 2 are photographs of burrows of *albifrons* taken in a Satsuma orange orchard near Round Lake, Jackson County, Florida. The burrows of *albifrons* and of the related subspecies *leucocephalus*, in the white sand dunes of the coastal region, are naturally different in appearance, owing to the difference in the material that is excavated. In the latter region, the holes of *Peromyscus* are not always readily distinguishable from the much more numerous ones of the ghost-crab (*Ocypode albicans*), and indeed it seems possible that the same burrows may be occupied interchangeably by these two very different animals.

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NOTES ON THE TEXAS COTTON AND ATTWATER WOOD RATS IN TEXAS

By John K. Strecker

On account of the present scarcity of hawks, owls, and large serpents in portions of the Brazos Valley, Texas, native rats and mice have so increased in numbers that their depredations have assumed almost the proportions of a plague. Within the past year, I have made frequent half-day visits to a farm owned by relatives, and located five miles north of Waco on the east side of the Brazos River. White Rock Creek flows through its southern end and a considerable part of the land borders the river on the west. The elevation, on which is now located the owner's residence, the barns, and a renter's small dwelling house, was in early years the site of an ancient Indian village, as is attested by the numerous arrowheads, scrapers, and partially worked flint rejects which are frequently brought to light by plow and spade. Along the creek and river banks are quantities of drift material which during rises was carried high above the normal water level. In these stream bottoms also are many rotten stumps and fallen trees, which provide suitable abiding places for rats and mice.

The majority of the rodents in the immediate neighborhood of the house are, of course, the introduced brown rat (*Rattus norvegicus*) and house mouse (*Mus musculus*), both species being abundant. The mice make inroads on the food of stock and chickens, while the rats take their toll, it is said, of a considerable number of young chicks. As a result of the destruction by storm of a large poultry house, large sheets of tar paper were scattered over the farm. Last spring and summer (1927), before this paper was finally gathered together and destroyed, each sheet provided a cover either for a permanent home for the smaller species or a lurking place for one of the larger.

COTTON RAT

Along the edge of the lower cotton field, which skirts a large garden patch, Texas cotton rats (*Sigmodon hispidus texianus*) and Texas white-footed mice (*Peromyscus leucopus texanus*) are now (June, 1928) numerous. Without going more than two or three yards from the road dividing the field and garden, it is possible for one to capture or kill a dozen or more of the rats in a few minutes time, for, during the day, they lurk under and around every piece of wood and tin, and even among large clods of earth.

In the spring of 1927, cotton rats were scarce as compared with their abundance at the present time. Unless those that were already on the ground increased in numbers through breeding to the proportions of a regiment within a few months' time, most of them must have come in from elsewhere soon after the cotton had begun to mature in the late summer. In fact the increase was so noticeable (I visited the farm about once each week) that it seemed as though we were in the midst of a typical invasion of the "tramp rat," as this species was named by H. P. Attwater in his field notes on the mammals of Bexar County.[1]

Sigmodon was so rare on the Traverse farm in the spring of 1927 that one dead specimen and two living ones were all that we found after a long search, although we turned over every log in the bottoms and every accumulation of trash large enough to have concealed a rodent's nest. Late in the fall, accompanied by three energetic boys, we made another raid on the cotton rats along the Brazos River in an effort to discover something about their home lives at this time of the year. One afternoon we found forty of different sizes in less than an hour. The majority of them were living under logs and fallen branches. Sometimes as many as three nests would be found under one log. Some of the young rats were quite small, probably only a week or so old. In one nest we found six, in another seven, young cotton rats. Bailey[2] mentions one female with eleven embryos. We next followed the windings of the Brazos to its junction with White Rock Creek, and on the banks of the latter stream, in passages under exposed roots and inside of partially hollow trees, we discovered several cotton caches of the Texas cotton rat. These caches were all filled with a quantity of cotton lint, most of it being, as the farmers express it, "ginned by the rats;" that is, the rats had eaten the seeds and the work of their teeth had left it in almost prime condition for compressing. One hollow in a rotten tree appeared to contain an unusual amount of the fleecy staple, so we decided that we would clear it out and estimate the quantity. We found that the cache contained more than a peck of cotton.

Across the creek and north of the old Lattimore gravel pit (a famous bone deposit, in which have been found the remains of mammoths, camels, prehistoric horses, sabre-toothed tigers, and other Pleistocene beasts) is another cotton field. At the lower (south) end of this field are the remains of some freight cars which have wantonly been permitted to rot and rust in the weather. In each of the car wheels are three

[1] Bull. Amer. Mus. Nat. Hist., 1896, vol. 8, p. 62.
[2] Proc. Biol. Soc. Washington, 1902, vol.15, pp. 101–116.

holes large enough to permit the entrance of a good-sized cotton rat, and in one of the wheels of the truck of one car a pair had constructed a nest of cotton, filling the entire hollow portion of the wheel. About a month previous, another old car had burned and I believe that specimens of *Sigmodon hispidus texianus* were indirectly responsible for its final destruction. A Mexican employed on the farm was burning some grass, and loose planks attached to the car caught on fire. The Mexican extinguished the blaze, but later in the night the car was discovered in flames and this time it burned down to the tracks. In two of the wheels at one end of the car were quantities of vegetable matter, such as loose grass, plant fibres, and strippings from cotton stalks that had been only partly consumed. All of the wheels at the other end of the car were well gutted but some few remaining fragments of burned matter indicated that at least one of them had contained a mass of cotton. I imagine that smoldering sparks in these nests caused the ultimate destruction of the car.

Vernon Bailey,[3] in his account of the habits of the Texas cotton rat, says: "Along the edge of the cotton fields they are especially numerous, and the runways opening into the fields are fairly lined with cotton that has been pulled from the bolls and dragged under cover, where the seeds can be eaten in safety." In his detailed account, this writer speaks of no great caches like those found by us. On the other hand, we found in runways comparatively little cotton to suggest that much of their feeding was done in such places. The proximity of the lower field to the wooded bottom with its many hiding places may have induced the rats to gather large accumulations of lint in order to provide themselves with the means of keeping warm in cool weather and of having on hand an abundant food supply of seed.

In this section of Texas, on account of the mildness of recent winters, cotton rats are not compelled to keep to cover during any considerable portion of the season. Therefore most of their habitations are mere shallows under fallen trees and the exposed roots of living ones. The nests in which the young are brought forth are somewhat deeper. In the sleeping burrow, there is usually a small quantity of dried grass, but the retirement burrow of the female is well lined with grass, cotton-stalk strippings, and rarely a little cotton. Nests in the bottoms that were more than fifty yards from the cotton field contained only a few fragments of lint.

[3] North Amer. Fauna, no. 25, 1905, p. 116.

The works and habitations of the cotton rat, temporary and permanent, may be classified as follows:

Permanent:

Roads and paths (runways).—In some cases "lined with cotton" (Bailey).

Burrows in loose soil, usually in soft, grass-covered banks, leading to their permanent homes. A large number of burrows lead into one habitation, which is frequently used by a number of rats, old and young, probably all of the same family.

Retirement burrows under logs. Here the young are brought forth. Well lined, usually deep, and as a rule, close to the roots of a near-by tree.

Temporary:

Sleeping quarters under logs—ordinary rat nests lined with grass. Sometimes in covered burrows, but usually the log provides the roof.

Winter caches of cotton, used to provide warm sleeping quarters and an auxiliary storeroom for food. Usually under the roots of partially rotten trees and the bases of stumps. One contained seed in such form that it appeared as though it had been purloined from some farmer's already gathered store.

Winter nests above ground. Those in the car-wheels well illustrate this type of nest.

As is suggested in the first paragraph of this paper, raptorial birds are now scarce in the neighborhood of the Traverse farm. One Florida barred owl, two barn owls, two Swainson's hawks, and a few Florida red-shouldered hawks are the only individuals that I have observed there on almost weekly visits covering a period of more than a year. A few coachwhip, blue racer, and gray pilot snakes are found in the neighborhood, and these, together with the hawks and owls, are about the only wild enemies that assist in controlling the rats. The dogs on the farm frequently kill *Sigmodon*, and a nursing cat with three kittens brought in specimens daily while she was attempting to wean her young ones.

Cotton rats are very destructive to ripening tomatoes. In one truck garden practically every third ripe tomato was a mere shell. As these rats feed in the daytime, they are often caught at their misdemeanors. Reports of the depredations of "short-tailed field rats" have come in from all sections of McLennan County. One farmer reports the slaughter, by himself and two sons, of 135 field rats. Another

reports that, in his neighborhood, several hundred were killed in a rat hunt.

WOOD RAT

Until within recent years, Attwater's wood rat was a scarce animal in this section of the Brazos Valley. In my paper on the mammals of McLennan County I say that it is principally found along the rocky banks of the Bosque River and Bluff Creek. Now it is scattered abundantly along the wooded banks of the Brazos River and other streams where cliffs and rocky hollows are less abundant. The farmer who attempts to add to his income through the sale of the fruitage of a few pecan trees is a great sufferer from the pilferings of *Neotoma floridana attwateri*. One nest (or cache) was found which contained nearly a bushel of pecans. It was located in a hollow in the stump of a fallen tree. The stump and base of the tree were covered by quantities of trash, and the pecans were discovered by boys who were digging around the stump.

My farmer friend was complaining that while in the evening he noticed large quantities of nuts lying on the ground under his trees, the next morning scarcely a nut was to be found. He was at first inclined to believe that human thieves were responsible for his loss. An investigation disclosed that the Attwater wood rat was making away with the pecans. The trees were only a few steps from a corn-field in which stalks were still standing. On examining each corn stalk nearest the trees, two or three nuts were found temporarily hidden by the rats until such time as they could transfer them to their permanent winter cache. Some of the wood rats were compelled to cross the shallow stream in order to carry pecans from the vicinity of the trees to their homes along the sides of the rocky washes on the opposite bank of the creek. They selected a place where the water was only two or three feet across and, judging by their tracks, must have made relay leaps from one to another of the leaf masses, stones, and imbedded chunks that jutted out of the water.

While some of the *Neotoma* have permanent homes among bushes, trash piles, and fallen timber, many others occupy crevices and caves in the rocky bluffs from which the stream gets its name. Wood rats are now reported from every farm along the Brazos River from its junction with White Rock Creek to a point ten miles above. They are also reported from the lower Brazos and Tehuacana Creek, south of Waco. Two boys, requested to bring in "hairy-tailed rats," caught many specimens at Moore Springs, and reported them as being very abundant.

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A WEASEL FIRES THE FLASH

By Tappan Gregory

[*Plates 18–19*]

Ever since a least weasel (*Mustela rixosa allegheniensis*) was killed near my home in Northfield Township, Illinois, in the fall of 1927, I have been on the alert for an opportunity to photograph one of these little killers with the trap camera. I hoped that when one had appeared, so close to our own small patch of woods, more might be found living there. But none ventured again near the chicken-house as far as I could ascertain, and casual efforts with a trap camera and bait, varying from fresh fish to chicken-heads set out at random in the edge of the woods, brought no reward, other than one picture of a cat.

It was not until near the end of February, 1928, that I received some encouragement, when a stiff northwest wind, accompanied by a drop in the mercury to 5°F., brought snow enough for good tracking. On the twenty-fifth it covered smoothly the floor of the woods, and here I found a record of the comings and goings of numerous rabbits and mice, and, more interesting to me, the tracks of at least one weasel, very definite and distinct, ranging pretty much the length of the woods. I thought at the time that they represented the travels of two weasels, but of that I do not feel nearly so certain now. One line of tracks led south out of the woods and into the open fields. A few minutes of back-tracking brought me to its source. Here I found an old stump, with a roomy hollow at the bottom, entered by a well worn ramp, which pitched steeply into the protecting blackness of the entrance in the center of the stump. The weasel tracks about the stump indicated, as I read them, that two individuals had left the den since the arrival of the snow, and that neither had yet returned.

That evening I placed in the snow at the foot of the stump, a white-footed mouse, caught in the early hours of the morning. The weather was moderating rapidly, and by the middle of the next day, the temperature was well above freezing. Fresh tracks came from the den and showed where a weasel had passed over the small patch of snow still remaining by its entrance, and the mouse had disappeared. Now I was convinced that it would be worth while to set the camera, but I was faced with something of a problem, as I had no fresh bait. I did have a white-footed mouse which had been killed six days before, and seemed to be in fairly good condition, as it had been lying outdoors and

the weather had been quite cold. So I made the best of it and wired this mouse to my trip, opened it up and placed it on its back in the snow. Ice was forming and the grass crackling when I went into the woods to make the set, which was completed at about 6:15 p.m. The flash was heard at 10:30 that night and when I visited the stump early the next morning, the mouse and the wire fastening it to the copper trip were both gone and the trip wires themselves were bent. As well as I could judge, the number of tracks had been augmented once more. The picture (pl. 18, fig. 3) shows a weasel in full flight, one leap carrying it from the top of its ramp to the mouse bait. I can visualize it popping up out of its den, its keen sharp eyes eagerly scanning the surroundings, discovering this unexpected treasure so unbelievably close at hand, pouncing at once, with a lightninglike thrust to preclude the possibility of escape on the part of the poor dead bait. I hesitate somewhat to submit this picture because, of course, the image of the weasel is greatly blurred. The maximum speed of my shutter is $\frac{1}{200}$ second, which is not fast enough to stop motion in a weasel on the jump. But it is to me such an interesting illustration of action that I venture to include it.

February 28 was a beautiful, clear, mild spring day, with the temperature probably well above 50°F. I had caught two mice the twenty-seventh and put one by the weasel den sometime after midnight. I found it still there the next morning. As is usual with our spring weather in the vicinity of Chicago, before ten o'clock on the evening of the twenty-ninth, the temperature was below freezing again. When I went to reset on the twenty-eighth, the mouse was gone, but it may well have been taken by dogs during the daytime. The second mouse was substituted as bait, and the set completed soon after nine. Practically all the snow had melted away from around the stump. The night was clear with only a light northwest breeze stirring and the moon just about at the first quarter. I made an inspection at eleven o'clock, but found everything as I had left it, and it was not until 2:00 a.m. of the twenty-ninth that the flash was discharged. My visit in the early morning disclosed the black wire, which fastened the mouse to the trip, leading into the mouth of the den, but still attached to the trip itself. The mouse had been pulled loose. Of course, the flash was set off when the weasel had hardly more than started to pull the bait back into the den, yet the tenacious little marauder apparently kept its hold and continued into its sanctuary in the old hollow stump (pl. 19, fig. 4). What disposition was finally made of the mouse, I do not know. No snow is visible in this picture because I had scattered

a few leaves to cover my trip as well as possible. During the next twenty-four hours, the temperature remained quite consistently below freezing and we had occasional snow flurries. No more mice were caught and I was therefore driven to the necessity of taking a short lead wire from my copper trip towards the camera in the hope that the weasel might stumble over it in following the usual hunting route from the den. Operations were completed by 9:30 on the evening of the twenty-ninth and at one o'clock in the morning on March 1, the flash was heard again. The weasel had played its part, but again the image is blurred by motion (pl. 19, fig. 5). It appears to be swinging its weight entirely on one fore foot, reaching out to stride ahead with the other fore foot, both hind feet being clear of the ground. I found the trip wire unbroken and the two copper wires of the trip not in contact, though the gap between them is not normally more than $\frac{1}{8}$ inch.

Lacking a mouse for bait, I set on March 1 with a small piece of fresh perch anchored to the trip wire, which I had left in place, and partially buried, but though the night was fine and clear, with the mercury around the freezing point, nothing took the bait. By nine o'clock on the evening of March 2, the trap was once more set, baited with a white-footed mouse. Again I anchored the bait to the trip wire with another short length of wire, and buried it enough in the ground so that the weasel would have to work a little to get it loose. It was my hope that this might restrict the range of the animal's movements enough to eliminate some of the blur in the picture, but I was only successful in a small measure. It was clear and still that night and while the day had been a little warmer than the previous one, the mercury went below freezing again in the evening. At 12:45 a.m. on the third, I wakened with the sound of the flash in my ears. The mouse was gone when I reached the stump in the morning. I think I made the task a little harder than I meant to for the weasel, because it apparently had quite a tough time loosening the bait. The picture (pl. 19, fig. 6) indicates that its fore feet were firmly planted wide apart as if to give it a good purchase, and its tail was actively in motion. Both copper wires of the trip itself were badly bent, the cross trip wire was bent, the short anchor wire straightened out and the loose earth all kicked off the small wooden block on which the trip is mounted, and also off several inches of my cable, which I had carefully buried the night before. These first few pictures left me in some doubt as to whether or not they were all taken of the same individual. I found it almost impossible to make measurements on the stump which would

serve to indicate the size of the weasel by comparison. The pictures gave me an impression that the length of the animal's tail was not uniform in all of them and that its tip was not invariably definitely black.

I thought that it would be interesting to make the weasel stand on its hind legs and reach for my bait. With this in mind, I hung up a white-footed mouse on the side of the stump, its nose 8½ inches from the ground, completing my set at ten o'clock in the evening. I do not know what time the flash went off, but on the morning of March 4, I found the trap sprung and the mouse gone. The wire which had held the bait, fastened to a staple on the stump, together with the staple itself, were dragged into the passageway of the den. Judged from the result, what a complete failure my experiment proved to be (pl. 19, fig. 7)! I had no doubt that I could accomplish what I wanted by moving the bait far enough from the entrance of the den, so the next night I hung up a white-footed mouse, this time *bairdii* instead of the usual *leucopus*, at the far edge of the stump, with its nose nine inches from the ground. I kept hoping to get some check in this way on the size of the weasel, as well as a better view of its tail. Once more I was frustrated and obtained only the weasel's head in the picture (pl. 19, fig. 8). I am sure it did not reach for the mouse except from the back of the stump, as shown, because the set was so delicate that the slightest touch would have discharged the flash. Once again the mouse had disappeared, and the wire was pulled from the staple and straightened out towards the entrance of the den. It occurred to me that I might be hanging the bait a little too high, so on the night of March 5, having no mouse, I took a small piece of raw beefsteak and suspended it from my staple so that the top of it was 5¼ inches from the ground. I examined the approach by which the weasel had taken my bait the night before, and discovered a little ledge about three inches from the ground, on which the weasel evidently stood to reach for the mouse. The edge of the stump over which its head appears was six inches above the ledge.

The weather continued without much variation and by this time the moon was full. Shortly before 3:00 a.m., March 6, the flash was heard again for the first time in three nights. This time the weasel hung way down the face of the stump to reach the bait (pl. 19, fig. 9). I think it must object seriously to standing up or reaching up from the ground. No other conclusion is consistent with the contortions shown in the last three pictures. That was the weasel's last appearance. Though I offered fresh meat and white-footed and house mice, the bait was never

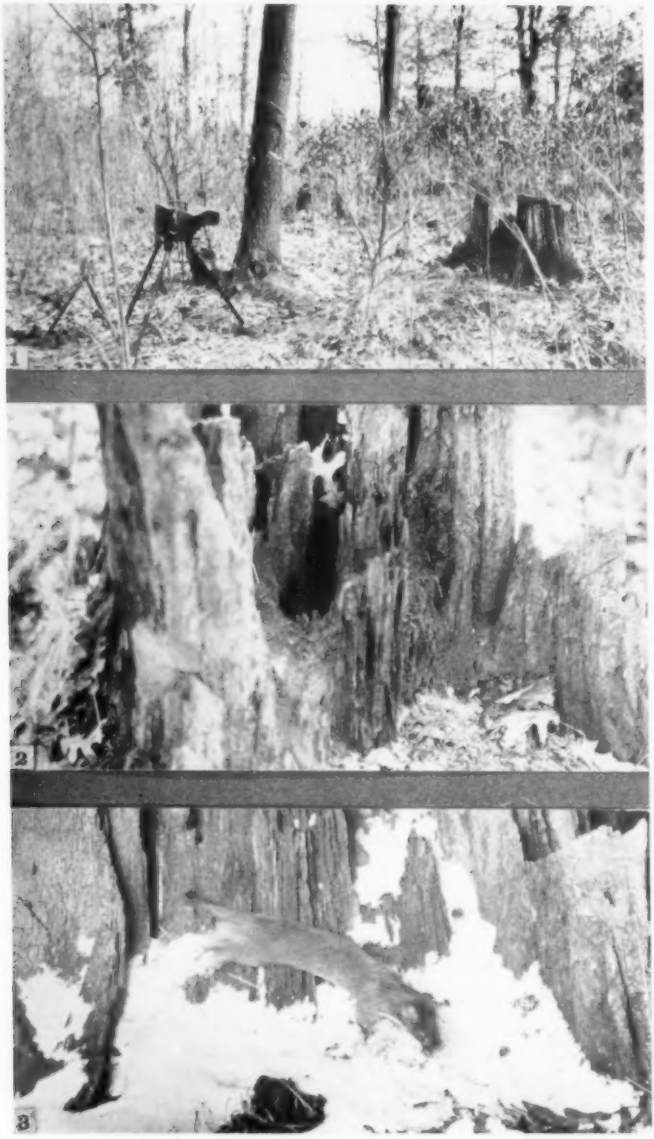

FIG. 1. CAMERA SET AT WEASEL DEN. FIG. 2. THE ENTRANCE TO THE WEASEL'S DEN. FIG. 3. WEASEL POUNCING ON MOUSE BAIT. FEBRUARY 26, 1928

FIG. 4. WEASEL DRAGGING MOUSE INTO DEN. FEBRUARY 29, 1928. FIG. 5. ON THE MOVE IN CHARACTERISTIC ATTITUDE. MARCH 1, 1928. FIG. 6. TUGGING TO FREE THE BAIT. MARCH 3, 1928. FIG. 7. THE RESULT OF THE FIRST EFFORT TO MAKE THE WEASEL REACH FOR THE BAIT. FIG. 8. ANOTHER EXPERIMENT THAT FAILED. FIG. 9. THE WEASEL'S LAST APPEARANCE. MARCH 6, 1928

again touched and soon the stump and the den took on the appearance of a deserted abode. So nothing was gained by my elaborate experiments. Instead of obtaining good pictures of the weasel's tail, quite the opposite effect resulted, and I succeeded only in eliminating the tail altogether from the pictures. I know no more now than I did as to the identity of my subject or whether or not there were more than one.

Chicago, Illinois.

AN ATTEMPT TO BREED COTTONTAIL RABBITS IN CAPTIVITY

By Lee R. Dice

It is not difficult to keep cottontail rabbits (genus *Sylvilagus*) in good condition in captivity if a few important necessities are provided. Any commodious cage can be used, but there must be a compartment into which the animal can retire and be free from observation. Otherwise the rabbit usually will become excited and is then likely to injure itself by dashing against the sides of the cage. A few individuals that I have reared have been tame enough to sit out when persons were working in the same room, but most are shy and remain hidden when a person is near.

My cages are 60 inches long by 30 inches wide and 16 inches high. They are constructed of a light framework of wood boards, over which 1-inch mesh poultry netting is stapled to form the ends, back, and top. The bottom is covered by a sheet of zinc, which is turned up at the edges, except in front. Two doors, hinged at their outer ends, form the front of the cage. These doors are mostly of wire screen also. Inside the cage is a movable box, 8½ by 10 by 20 inches, into which the rabbits can retire and be hidden.

A wire rack is provided for hay, and a heavy glass dish for oats. Water is supplied in an aluminum cup, the handle of which projects through one of the meshes of the wire screen of the door and is held by a short stick of wood.

The food for the adult animals has been hay and whole oats. Probably rolled oats would be better than whole oats. Sufficient hay is given so that it is constantly present in the hay rack. The amount of oats fed should be just what the animal will readily eat in one day. Only

one feeding a day is needed, for the animals are active mostly at night. Once or twice a week some green food is given, such as carrots, apples, dandelion, or lettuce.

The most important food item for both young and old rabbits is cod-liver oil. This is fed about twice a week or more frequently. It is mixed in corn-meal or rolled oats and placed in a glass dish. About a half teaspoonful of the cod-liver oil mixed in enough meal to absorb it seems to be sufficient for a semi-weekly feeding for one animal. If the oil is not fed, the young rabbits fail to grow; they develop rickets and soon die. Even old rabbits do not keep in good condition unless the oil is fed regularly.

Very young rabbits secured wild from the nest can often be successfully reared by feeding cow's milk from a medicine dropper. They soon learn to drink from a spoon and are not long in learning to drink from a dish placed in the cage. At a very early age they will nibble green grass and dandelion leaves. Of this green food they eat a relatively enormous quantity in a day. Rolled oats or bread should always be fed in addition to the green food, and cod-liver oil should be added as soon as possible. Only as much green food should be given each day as will be completely eaten, and that which remains uneaten should be removed before it can ferment.

Young rabbits with the mother need only be supplied rolled oats, beginning as soon as they leave the nest, and some green food, such as dandelion or lettuce. All young rabbits must of course have a warm nest of cotton and excelsior or similar materials.

It is very difficult to get cottontail rabbits to mate in captivity owing to the fighting which takes place when two are left together. Every animal older than four weeks must for safety be kept in a separate cage. Females can not be placed in the cage of the male for mating, as is done with domestic rabbits, for both individuals are so frightened that they hide in the farthest corners of the cage. My method has been to leave a male and female side by side in adjacent cages for several days. Then a door between the two cages is opened for one night. In the morning there is nearly always much evidence of fighting, fur scattered widely, scratches on the animals, sometimes an eye nearly knocked out, and rarely an animal dead. Occasionally, the two animals agree peacefully together, and I have had a pair live together for several days with a resultant litter. But a litter may appear following a mating where there were evidences of much fighting. I believe that more success in matings might be obtained through the use of larger

quarters in the mating pens and with special hiding places to which an attacked animal may retreat.

So far I have secured only three litters of cage-bred cottontails, all of them of the subspecies *Sylvilagus audubonii neomexicanus*, from Rago, Kansas. The parents were procured fully grown from a dealer. From one pair of parents two litters were obtained, one litter containing three young, the other five. From the second pair a single litter was secured consisting of a single young one. Attempted matings of several pairs of *Sylvilagus floridanus mearnsii* from Michigan and Iowa, and of *S. f. similis* from North Dakota, have failed, as have all attempted crosses of subspecies and of species. Among the specimens used in attempted crosses were two female *S. audubonii baileyi* from Colorado, in addition to individuals of all the other subspecies above named.

For the first litter of *Sylvilagus a. neomexicanus* that was secured, the parents were left together on the night of April 16, 1926. In the morning there were evidences of much fighting. Three young were found in a nest on May 14, but they may have been there several days before being discovered. The same pair was placed together during the night of June 21, and on July 22, five young were found in a nest.

A second pair of the same subspecies were together the nights of April 16 to 19. At first peaceful together, there were later signs of fighting. A single young one was discovered in the cage on May 25, when it was large enough to leave the nest.

From these scanty observations it is indicated that the period of gestation in this subspecies may be 28 days or less. Also, two or perhaps more litters may be reared by one mother in the same season.

The nests in all these instances were constructed in a deep bed of straw placed in the cage for the purpose. The female evidently formed a cavity in the straw and lined this with fur from her body. The straw was then rearranged over the surface so that there was no indication of the presence of the nest.

I did not dare examine any of the very young rabbits and can give no description of the condition at birth of these particular litters. However, several litters of young have been born in my cages from mothers bred in the wild before being received. In every case the young were found dead, presumably from the lack of a suitable nesting place.

The young rabbits when born have the eyes shut, but there is a close growth of stiff hair over the whole body. Over the back and sides the hair is blackish and about 5 millimeters in length; on the ventral

portion of the body the color of the hair tends to be whitish, and its length is slightly less than on the back. There is a white star on the middle of the forehead. The ears, tail, and limbs are well developed. The above description has been drawn up from three specimens of newly born young forming a litter born to a wild female of *Sylvilagus a. neomexicanus* from Rago, Kansas, shortly after her arrival in Ann Arbor, March 19, 1927. These three young were preserved in alcohol, and so preserved now weigh, respectively, 33, 35 and 40 grams. Of the largest individual the tail measures 5.0 millimeters, the ear 11.5 millimeters from the notch, and the hind foot 18.7 millimeters, all measurements being taken from the alcoholic specimen. The growth of the young rabbits is quite rapid. In the first litter of *Sylvilagus a. neomexicanus* secured, the young born on May 14 or perhaps a few days earlier were out of the nest on May 25, when they were presumably eleven days old or a little more.

This first litter was lost by being left too long with the mother. On June 18, when they were about five weeks old, I found all three young with backs torn and bleeding, and they all died soon afterward. It is possible that that damage was inflicted by the young ones on one another, for I have found the little fellows rather pugnacious. In this case, however, I feel sure that it was inflicted by the mother, who was perhaps trying to drive away the young at weaning time and anxious to escape their importunities to suckle. From this indication, the young in this subspecies are weaned at about four weeks of age. In all subsequent litters I placed in the cage little wooden tunnels in which the young might hide. These tunnels were small enough so that but one young could enter at a time and heavy enough not to be easily upset.

From my observations on these captive cottontails, I have gained a somewhat different opinion of the rabbit temperament than one obtains from the observation of wild cottontails fleeing from a man with a gun. These cottontails are by no means defenseless creatures, but they can inflict severe wounds by the kicks of their powerful hind legs. Some individuals defend themselves by sitting on their haunches and striking with both front feet in a rapid stroke. When taken in the hand, a few attempt to bite with their powerful teeth.

The skin of these rabbits is easily torn and if the skin is much injured in a fight the animal usually dies. The bruising and buffeting received in fighting also must be severe for such a small animal.

Any rabbit entering the cage of another individual apparently stands a good chance of being attacked as an intruder, irrespective of sex. But

my chances of observation at night have been few and I can not give more than a general impression in this regard.

The several subspecies show much variability in temperament. *Sylvilagus f. mearnsii* is, judging from examples I have had, fairly bold, and not very pugnacious; *S. f. similis* is somewhat more shy; *Sylvilagus audubonii neomexicanus* and *S. a. baileyi* are more shy, but also more pugnacious than either of the subspecies of the *floridanus* group observed. However, there is also much individual variation. Of two very young *baileyi* taken at Lamar, Colorado, the female was far more pugnacious than the male, and she was always ready to attack an extended finger; on the contrary, the male was very docile. Unfortunately he died young. Of two very young *baileyi*, taken near Fort Morgan, Colorado, and placed in the same cage overnight, the female, which was somewhat the larger, injured the male before morning so severely that he had to be killed, the skin being torn off much of his back and rump.

The cottontail rabbit is an interesting animal for study, and much information about its habits and life history can be obtained by the observation of captives. The problem of getting it to breed regularly in captivity can doubtless be solved, but its proclivity for fighting renders it a difficult animal for the laboratory.

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ECOLOGY OF THE ECTOPARASITES OF NIGERIAN RODENTS AND INSECTIVORES

By A. S. Pearse

Rodents and insectivores furnish excellent material for the study of ecological problems. They are small in size and hence are rather easily trapped and examined. They usually occur in considerable numbers and are therefore not particularly difficult to obtain. They show a considerable variety of relations to habitats. Their parasites, when studied with other features of environment, give an unusual insight into their ecology. In this paper an attempt is made in a limited way to describe the factors that favor or hinder the occurrence of ectoparasites on rodents and insectivores, with the twenty-nine species that the writer studied in Nigeria as a basis for discussion.

Nigeria is divided into a number of zones which for the most part extend from east to west. Along the coast are lagoons and a wet forest

where mangroves and oil- and wind-palms flourish. North of this, and particularly along the Niger River and its tributaries, there are rain forests of gigantic trees. Between the coast and the desert are several hundred miles of savanna, where tall guinea grass and scattered trees are characteristic features of the landscape. Beyond this is steppe and desert. During the latter part of the year 1926 the writer studied rodents and insectivores at four localities where conditions were quite different from one another. These are characterized briefly in table 1. In Nigeria the rainy season begins in May and June and closes in October. The writer was in the south during the coolest and rainiest season and in the north during the dryest part of the year. Seasonal differences may have influenced the numbers of ectoparasites on the mammals studied, but, as the degree of such influence is not certain, the results

TABLE 1

Localities visited in Nigeria, 1926

LOCALITY	DATES	CHARACTER	ANNUAL RAINFALL	MEAN TEMPERATURE
			inches	*degrees F.*
Lagos	July 23–Oct. 16	Wet forest	72	81.1
Ife	Nov. 3–Nov. 7	Rain forest	57	79.7
Ibadan	Oct. 25–Nov. 7	Savanna	49	80.8
Kano	Nov. 28–Dec. 11	Steppe desert	34	80.0

are considered without reference to them. The writer does not feel that seasonal variations were of particular importance.

Detailed accounts of the country (Pearse, 1927), people (1928), fleas (1928b), and arachnids (1928a) have already been published. The present paper will be limited to a brief list of the ectoparasites found on rodents and insectivores and to the ecological factors that apparently have relation to the occurrence of ectoparasites. Thanks are due to the following persons who were kind enough to help with identifications: Mammals, Maj. C. M. Ingoldby; fleas, Dr. Karl Jordan; lice, Prof. G. F. Ferris; ticks, Dr. C. Warburton; and mites, Dr. H. E. Ewing.

Nigeria is not an easy country in which to carry on work. In the south it is hot and sultry; in the north it is dusty. There are fevers, filarial worms, fleas, ticks, mites, tsetse flies and other pests to harass anyone who goes afield. Civet cats carry traps and their contents into the bush; shrews often steal or mutilate small mammals; ants quickly cut up and devour any animal that is not soon removed from a trap.

TABLE 2

External parasites on Nigerian rodents and insectivores. Specific infections for hemimerids and lice are not given, but these parasites are included in the totals in the right hand column. In the columns marked "total" the first number indicates the individuals infested and the second shows the total number of parasites.

	LOCALITY	NUMBER EXAMINED	FLEAS			LICE			TICKS			MITES			TOTAL PARASITES TO EACH INDIVIDUAL
			Total	Per cent infested	Parasites to each individual	Total	Per cent infested	Parasites to each individual	Total	Per cent infested	Parasites to each individual	Total	Per cent infested	Parasites to each individual	
Aenomys hypozanthus	If	1	0	0	0	0	0	0	0	0	0	1 1	100	1	0
Arvicanthis mordax	K	9	3 7	33	0.8	1 53	11	5.9	6 21	67	2.3	0	0	0	9.0
Arvicanthis rufinus	Ib If	6	1 2	17	0.3	0	0	0	6 128	100	21.3	4 54	67	9	21.6
Atelerix spiculus	K	5	5 14	100	2.8	0	0	0	5 77	100	15.4	0	0	0	17.6
Atelerix spinifex	K	2	2 11	100	5.5	0	0	0	2 7	100	3.5	0	0	0	9.0
Cricetomys buchanani	K	10	7 290	70	29.0	0	0	0	3 6	30	0.6	3 15	33	1.5	31.1
Cricetomys emini	If L	18	0	0	0	0	0	0	10 140	56	7.8	4 148	36	8.2	17.3
Crocidura sp?	Ib L	15	0	0	0	0	0	0	3 5	20	0.3	10 414	67	27.6	28.9
Crodicura manni	Ib KL	19	6 54	32	2.8	1 24	5	2.3	6 254	31	12.8	4 62	21	3.3	21.2
Euxerus erythropus mauritus	L	2	0	0	0	0	0	0	2 22	100	12.0	1 2	50	1.0	13.0
Funisciurus anerythrus	If L	12	1 3	8	0.3	0	0	0	1 3	8	0.3	7 155	58	12.9	13.5
Funisciurus auriculatus oliviae	L	5	0	0	0	0	0	0	0	0	0	4 671	80	134.2	134.2
Heliosciurus isabellinus	L	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Hybomys univittatus	L	44	1 1	2	+	4 80	9	1.8	2 4	5	0.1	9 150	20	3.4	5.3
Leggada musculoides	Ib KL	49	0	0	0	0	0	0	4 7	9	0.2	25 98	53	2.0	2.2

TABLE 2—*Concluded*

	LOCALITY	NUMBER EXAMINED	FLEAS			LICE			TICKS			MITES			TOTAL PARASITES TO EACH INDIVIDUAL
			Total	Per cent infested	Parasites to each individual	Total	Per cent infested	Parasites to each individual	Total	Per cent infested	Parasites to each individual	Total	Per cent infested	Parasites to each individual	
Lemniscomys striatus	Ib	24	2	4	0.1	0	0	0	14	59	3.3	21	88	10.5	13.9
	IfL		2						86			353			
Lepus zechi	Ib	2	0	0	0	0	0	0	2	100	5.5	2	100	5.5	11.0
									11			11			
Lophuromys sikapusi	Ib	11	0	0	0	0	0	0	1	9	0.1	8	73	20.4	20.5
	IfL								1			224			
Malcomys edwardsi	L	20	0	0	0	0	0	0	0	0	0	8	40	3.2	3.2
												64			
Mastomys sp?	If	4	1	25	0.3	0	0	0	0	0	0	2	50	0.5	0.8
			1									2			
Mastomys erythroleucus	Ib	31	1	3	+	0	0	0	3	10	0.2	27	87	12.8	16.2
	IfL		1						5			396			
Mus musculus	L	3	0	0	0	1	33	16.6	0	0	0	0	0	0	16.6
						50									
Praomys tullbergi	L	90	1	1	+	0	0	0	26	27	2.0	73	76	4.5	6.5
			1						197			439			
Protozerus stangeri nigeriae	If	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Rattus rattus	If	78	15	19	0.3	0	0	0	2	3	+	16	21	0.4	0.7
	L		22						3			28			
Taterillus gracilis angelus	K	9	3	33	0.5	0	0	0	6	67	1.6	2	22	1.3	3.4
			5						14			12			
Taterona kempi	Ib	26	2	8	0.1	0	0	0	15	58	6.9	24	93	35.0	42.0
	K		2						149			911			
Thryonomys swinderianus	L	1	0	0	0	1	100	8	1	100	28.0	1	100	20.0	56.0
						8			28			20			
Uranomys foxi	Ib	1	0	0	0		0	0	0	0	0	0	0	0	0
Lagos	L	330	2			6	1.7	0.39	59	16.6	1.34	186	52	7.7	10.29
			26	5	0.7	138			478			2753			
Ife	If	27	2	7.4	0.15	0	0	0	5	18.5	0.22	17	63	10.4	11.21
			4						6			281			
Ibadan, Oyo	Ib	69	2	4.2	0.4	1	1.5	0.35	29	42	4.3	49	71	19.5	24.19
			3			24			296			1349			
Kano	K	54	26	48	7.25	1	1.8	0.98	33	67	6.9	13	24	1.7	16.83
			392			53			373			89			

Many specimens were thrown away without examination because they were rendered imperfect by some one of these pests.

NIGERIAN RODENTS AND INSECTIVORES AND THEIR ECTOPARASITES

In the following lists, the number after the name of the mammal indicates the number of specimens examined. The first number after the name of a parasite indicates the number of individual mammals infested with it; the second shows the average number of parasites on each individual. The totals for all species and localities are given in table 2.

Aenomys hypozanthus Puch., 1

The one specimen of this rare rodent captured carried one mite, *Laelaps* sp.

Arvicanthis mordax Temm., 9

Xenopsylla cheopis Rothschild, 3:7; *Polyplax abyssinica* Ferris, 1:53; *Haemaphysalis leachi* Audouin, 6:21.

Arvicanthis rufinus Thomas, 6

Ctenocephalus canis Curtis, 1:2; *Izodes rasus* Neumann, 4:17; *Haemaphysalis leachi* Audouin, 4:111; *Laelaps* sp., 4:54.

Atelerix spiculus Thomas and Wroughton, 5

Ctenocephalus canis Curtis, 4:8; *Echidnophaga gallinacea* Westwood, 1:1; *Synosternus pallidus* Tasch., 4:4; *Xenopsylla cheopis* Rothschild, 1:1; *Rhipicephalus sanguineus* Latreille, 1:1; *Haemaphysalis leachi* Audouin, 5:73; *Amblyomma variegatum* Fabricius, 1:3.

Atelerix spinifex Thomas, 2

Ctenocephalus canis Curtis, 1:5; *Synosternus pallidus* Tasch., 2:6; *Rhipicephalus sanguineus* Latreille, 2:4; *Haemaphysalis leachi* Audouin, 1:3.

Cricetomys buchanani Thomas, 10

Echidnophaga gallinacea Westwood, 3:256; *Xenopsylla cheopis* Rothschild, 5:12; *Xenopsylla equisetosus* Enderl., 2:22; *Rhipicephalus evertsi albigeniculatus* Warburton, 1:1; *Haemaphysalis leachi* Audouin, 1:3; Unknown ticks, 2:2; Laelapine mites, 3:15.

Cricetomys emini Wroughton, 18

Izodes rasus Neumann, 10:140; Laelapine mites, 3:58; *Trombicula* larvae, 1:40; Unknown mites, 1:50; *Hemimerus talpoides* Walker, 4:21.

Crocidura sp., 15

Izodes rasus Neumann, 1:2; *Izodes* larva, 1:1; *Haemaphysalis leachi* Audouin, 1:2; *Laelaps* sp., 1:3; *Laelaps muricola* Trägårdh, 1:1; Laelapine mites, 1:20; *Trombicula* larvae, 8:390; Dipterous larvae, 2:16.

Crocidura manni Pet., 19

Echidnophaga gallinacea Westwood, 1:11; *Xenopsylla cheopis* Rothschild, 5:39; *Xenopsylla equisetosus* Enderl., 1:15; *Polyplax reclinata* (Nuttall), 1:24; *Ixodes rasus* Neumann, 1:9; *Haemaphysalis leachi* Audouin, 5:245; *Laelaps* sp., 1:11; Laelapine mites, 1:1; Unknown mites, 2:50.

Euxerus erythropus maestus Thomas, 2

Haemaphysalis leachi Audouin, 1:21; Unknown tick, 1:1; *Laelaps* sp., 1:2.

Funisciurus anerythrus Thomas, 12

Ceratophyllus consobrinus Jordan, 1:3; *Haemaphysalis leachi* Audouin, 1:3; Laelapine mites, 3:9; *Trombicula* larvae, 5:146.

Funisciurus auriculatus oliviae Dollman, 5

Laelaps muricola Trägårdh, 1:1; *Trombicula* larvae, 4:670.

Heliosciurus isabellinus Gr., 3

No parasites occurred on this tree squirrel.

Hybomys univittatus Pet., 44

Unknown flea, 1:1; *Hoplopleura* sp., 4:80; *Ixodes rasus* Neumann, 1:1; *Ixodes* larvae, 1:1; *Haemaphysalis leachi* Audouin, 1:2; *Laelaps* sp., 1:2; Laelapine mites, 4:30; *Trombicula* larvae, 5:118.

Leggada musculoides Temm., 48

Ixodes rasus Neumann, 1:2; *Ixodes* larvae, 1:2; *Haemaphysalis leachi* Audouin, 2:3; *Laelaps* sp., 9:39; *Laelaps algericus* Hirst, 16:48; *Laelaps liberiensis* Hirst, 1:7; *Tricholaelaps* sp., 1:4.

Lemniscomys striatus L., 24

Unknown fleas, 2:2; *Ixodes rasus* Neumann, 1:2; *Ixodes* larvae, 3:13; *Rhipicephalus sanguineus* Latreille, 2:7; *Haemaphysalis leachi* Audouin, 8:64; *Laelaps* sp., 13:154; *Laelaps muricola* Trägårdh, 3:37; Laelapine mites, 5:62.

Lepus zechi Matsch., 2

Rhipicephalus sanguineus Latreille, 1:1; *Haemaphysalis leachi* Audouin, 2:9; *Hyalomma aegyptum* L., 1:1; *Laelaps* sp., 2:11.

Lophuromys sikapusi Temm., 11

Haemaphysalis leachi Audouin, 1:1; *Heterolaelaps* sp., 4:160; Laelapine mites, 1:2; *Tricholaelaps* sp., 2:21; *Trombicula* larvae, 2:40; Unknown mites, 1:1.

Malacomys edwardsi Rochebr., 20

Heterolaelaps sp., 2:13; *Laelaps muricola* Trägårdh, 4:21; *Trombicula* larvae, 2:40.

Mastomys sp., 4

Xenopsylla cheopis Rothschild, 1:1; *Laelaps muricola* Trägårdh, 2:2.

Mastomys erythroleucus Temm., 31

Xenopsylla cheopis Rothschild, 1:1; *Izodes rasus* Neumann, 2:3; *Haemaphysalis leachi* Audouin, 1:2; *Heterolaelaps* sp., 3:15; *Laelaps* sp., 3:13; *Laelaps liberiensis* Hirst, 1:15; *Laelaps muricola* Trägårdh, 19:353; Unknown mites, 1:1; Dipterous larvae, 1:1.

Mus musculus L., 3

Hoplopleura intermedia Kellogg & Ferris, 1:51.

Praomys tullbergi Thomas, 96

Ctenocephalus cophrus Jordan & Rothschild, 1:1; *Rhipicephalus sanguineus* Latreille, 1:1; *Haemaphysalis leachi* Audouin, 24:195; Unknown ticks, 1:1; *Laelaps* sp., 1:11; *Laelaps muricola* Trägårdh, 63:368; Laelapine mites, 10:54; *Trombicula* larvae, 1:2; Uropodid nymphs, 1:4.

Protoxerus stangeri nigeriae Thomas, 1

This gigantic tree-top squirrel carried no ectoparasites.

Rattus rattus L., 78

Xenopsylla cheopis Rothschild, 15:22; *Izodes rasus* Neumann, 1:2; *Haemaphysalis leachi* Audouin, 1:1; *Laelaps* sp., 14:20; *Tricholaelaps* sp., 1:5; Unknown mites, 1:3.

Taterillus gracilis angelus Thomas, 9

Xenopsylla nubicus Rothschild, 3:5; *Izodes rasus* Neumann, 2:4; *Rhipicephalus sanguineus* Latreille, 1:4; *Haemaphysalis leachi* Audouin, 3:5; *Amblyomma variegatum* Fabricius, 1:1; Laelapine mites, 2:12.

Taterona kempi Wroughton, 26

Xenopsylla cheopis Rothschild, 1:1; *Xenopsylla nubicus* Rothschild, 1:1; *Rhipicephalus sanguineus* Latreille, 4:85; *Haemaphysalis leachi* Audouin, 11:64; *Laelaps liberiensis* Hirst, 1:25; Laelapine mites, 21:872; *Tricholaelaps* sp., 2:14.

Thryonomys swinderianus Temm., 1

Scipio aulacadi Neumann, 1:8; *Izodes rasus* Neumann, 1:14; *Rhipicephalus sanguineus* Latreille, 1:13; *Haemaphysalis leachi* Audouin, 1:1; *Trombicula* larvae, 1:20.

Uranomys foxi Thomas, 1

This rare mouse carried no external parasites.

DISCUSSION AND CONCLUSIONS

The ectoparasites that live on Nigerian rodents and insectivores are all arthropods and are therefore more or less alike in general structure, but the various groups show striking differences in distribution and in their relations to hosts and to ecological factors.

Fleas live where the climate is dry and in wet South Nigeria were

rarely found except on house rats, but in the arid North they were common on most of the species of animals examined. There are two species of great rats in Nigeria which live in burrows and are excellent hosts for fleas. That (*Cricetomys emini*) in the wet South, however, carried no fleas while the one (*C. buchanani*) in the dry North averaged 29 fleas to each individual. The house rats in the wet region near Lagos are the only small mammals that live in dry situations and are the only rodents that carry plague fleas. The rodents and insectivores in the bush near Lagos rarely carried fleas and never carried plague fleas. The spread of plague is therefore through house rats, and the "bush" rodents and insectivores are concerned little or not at all. There are few or no house rats at Ibadan, 150 miles inland, and none at Kano, 700 miles from the coast.

Lice showed specificity for particular mammalian hosts and were never common. Hemimerids were found only on the giant rat, *Cricetomys emini*, the four infested individuals carrying 21, an average of 1.2 each for the 22 individuals examined. Fly larvae were unusual and were found imbedded in the skins of the shrew, *Crocidura* sp., (13:1.1) and the guinea grass rat, *Mastomys erythroleucus* (3:3.2).

Ticks were found in both wet and dry climates, but a greater variety of species and greater numbers of individuals occurred in the arid North. They appear to be at their best in a dry country where there are scattered shrubs. Mites, on the other hand, depend on a close ground cover of vegetation. They reach their maximum in the 15-foot guinea grass (71:19.5), are present in considerable numbers in the rain forest (63:10.4) and in the wet, coastal forest (52:7.7), but become few in the desert (24:1.7). The rodents and insectivores living in the dry climate about Kano carried more fleas (48), lice (.98), and ticks (6.9) than those in other localities, but mites were fewest there.

Certain physical qualities, habits, and habitat preferences were related to infestation with ectoparasites. The small mammals most likely to be infested were those that ran on the surface of the soil. The tree-top squirrels, *Protoxerus stangeri nigeriae* and *Helioscuirus isabellinus*, carried no parasites. The squirrels living in lower trees and shrubs, *Funisciurus anerythrus* and *F. auriculatus oliviae*, and the tree squirrel, *Euxerus erythropus maestus*, which frequently feeds in the fields of the natives, had more parasites. The largest ground rodents studied in the South, such as the great "cut-grass" (*Thryonomys swinderianus*), the great Gambian rat (*Cricetomys emini*), and the hare (*Lepus zechi*), carried more parasites to each individual than represent-

atives of small species, such as the pigmy mouse (*Leggada musculoides*), the ubiquitous forest mouse (*Praomys tullbergi*), and the desert jumping mouse (*Taterillus gracilis angelus*), but there are many cases where animals of different species that were of approximately equal size show great differences in infestation. The short-tailed, striped, forest mouse (*Hybomys univittatus*) was caught in the same habitats with the long-tailed forest mouse (*Praomys tullbergi*), was about the same size and carried about the same number of external parasites (5.3; 6.5). Another long-tailed forest mouse (*Malacomys edwardsi*), which lived in the same habitats and was a little larger, carried fewer parasites (3.2).

The greatest average numbers of parasites to each individual were as follows:

Fleas:

Cricetomys buchanani, a gigantic burrowing rat of the steppe, 29.
Atelerix spinifex, a hedgehog of the steppe, 5.5.
Atelerix spiculus, a hedgehog of the steppe, 2.8.
Crocidura manni, an ubiquitous shrew, 2.8.
Arvicanthis mordax, a "guinea-pig" of the steppe, 8.

Lice:

Mus musculus, the house mouse, 16.6.
Thryonomys swinderianus, the "cut-grass" of the savanna and wet forest, 8.
Arvicanthis mordax, a "guinea-pig" of the steppe, 5.9.
Crocidura manni, an ubiquitous shrew, 2.3.

Ticks:

Thryonomys swinderianus, the great "cut-grass" of the savanna and forest, 28.
Arvicanthis rufinus, a "guinea-pig" of the savanna and rain forest, 21.3.
Atelerix spiculus, a hedgehog of the steppe, 15.4.
Crocidura manni, an ubiquitous shrew, 12.8.
Euxerus erythropus maestus, a forest squirrel that often visits the fields of the natives, 12.

Mites:

Funisciurus auriculatus oliviae, a tree squirrel that lives in low forest, 134.2.
Taterona kempi, a field rat of the savanna and forest, 35.
Crocidura sp.?, a shrew, 27.6.
Lophuromys sikapusi, a field mouse of the savanna and forest, 20.4.

Funisciurus anerythrus, a tree squirrel that lives in low forest, 12.9.

The food of the mammals considered here will be discussed in a later paper on internal parasites.

SUMMARY

1. In Nigeria 506 rodents and insectivores belonging to 29 species were studied. These were found in the wet forest on the coast, in the rain forest along the Niger, the savanna, and on the steppe 700 miles from the coast.

2. Fleas were most abundant on large animals living in a dry climate and frequenting more or less permanent homes. In the wet forest near the coast they were rare except in native houses.

3. Lice, fly larvae, and hemimerids were not common.

4. Ticks were most prevalent among low scattered shrubs in dry climates, but were also numerous in wet climates.

5. Mites were abundant where there was a ground cover of low vegetation and were infrequent in the steppe.

6. Habits and habitat preferences influenced the degree of parasitic infestation.

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MAMMALS OF THE CASCAPEDIA VALLEY, QUEBEC

BY GEORGE G. GOODWIN

Early in July, 1927, I made a short trip to the Gaspé Peninsula and spent six weeks collecting mammals in the valley of the Cascapedia River. My plan was to stay several days at intervals, from Chaleur Bay, on the south coast, north to Big Berry Mountain.

Some of the three hundred and fifty mammals secured, proved to be of particular interest, a fact which has induced me to publish the following report, briefly outlining results and presenting data acquired.

Childs Frick generously contributed the financial aid that made this trip possible, and his intimate knowledge of the country was of great assistance in selecting suitable collecting grounds. I am indebted to the U. S. Biological Survey for the loan of material to compare with the Gaspé specimens.

The Cascapedia River is in the Gaspé Peninsula, the extreme eastern portion of Quebec, south of the St. Lawrence. It rises in the southern watershed of the Shickshock Mountains and runs southeast to Big Berry Mountain, then flows southward, and, after a course of seventy miles through an undulating and timbered forest, enters Chaleur Bay. It is very swift, carrying a considerable head of water, and has a well graded channel, rising in 36 miles from sea level to about 400 feet, an

average of eleven feet a mile. After a heavy rain storm, the water is abruptly precipitated and the river almost immediately rises to a flood.

The valley of the Cascapedia River is in some places wide, with considerable areas of good alluvial land covered with forest, but in other places it is narrow. For most of the distance, from the coast to Big Berry Mountain, the valley is entrenched several hundred feet beneath the level of the uneven tableland. The surface of the country is a jumble of rough mountains, irregular steep ridges, hills, valleys and ravines. In the high mountains, spruce and balsam make up the forest. Poplars, birches, and alders grow along the banks of the river.

A lumber road from the coast to the Federal Zinc and Lead Mine, follows up the east side of the river. Thirty-five miles of the road are in the Cascapedia Valley, whence a branch road made by the mining company turns northeast along Berry Brook, following its northerly fork, at first through low ground until the blazed boundary line between Matane and Gaspé counties is reached. The road then rises rapidly to the mine which is in the township of Lemieux, ten miles from the river.

Beyond Berry Brook the lumber road continues to the forks of the Cascapedia River, about three miles up. One of the branches of the river, the Salmon branch, can be followed for 30 miles farther in a direction a little to west of north to a beautiful body of water two miles long, running between low mountains, Cascapedia Lake, 1,700 feet above sea level. The trail then ascends a gentle slope for a mile to a divide at 1,915 feet altitude. This dip in the Shickshock Mountains separates the high peaks of the Logan Range from the still higher peaks of Mount Albert and Tabletop Mountain, and is the lowest pass from the headwaters of the Cascapedia River to the north slope of the Shickshocks.

Stations at which collections were made are as follows: Red Camp, eight miles from the coast, in the farming district, and practically sea level; New Derreen, on the outskirts of the forest, four miles beyond the previous camp; Middle Camp, on the Cascapedia River, twenty miles inland, in the heart of a mass of rough mountain ridges and valleys covered with virgin forest; Big Berry Mountain, thirty-five miles up the river, the highest point and the end of the chain of mountains along the Cascapedia River.

The character of the country remains much the same from New Derreen to Big Berry Mountain: A typical boreal forest of the Canadian zone, covering successive steep mountain ridges, occasionally broken by wind-swept hill tops, or precipitous slides that afford no foothold for

vegetation. Beyond Big Berry Mountain, the valley opens up and the country becomes more rolling. Everywhere the ground is covered either with loose fragments of rock or fallen trees, more or less overgrown with a thick carpet of saturated moss.

From the summit of Big Berry Mountain there is a wide view of the Shickshock Mountains, including the Tabletop batholith to the northwest, Mount Albert to the north, and distant members of the Logan Range to the northwest.

Most of the small animals that are known to occur in the Gaspé Peninsula are represented in this collection. Big game was apparently plentiful. Two half-grown moose crossed the trail about fifty yards ahead of me at Big Berry Mountain, and the tracks were numerous along the banks of the river. Caribou were said to be common in the mountains, but I did not see any traces of them in the valley. A white-tailed deer on the trail at Middle Camp seemed quite tame and stood looking at me as I approached to within thirty or forty yards; then it flapped its tail and bounded away into the forest. Black bear tracks were seen both at Middle Camp and Big Berry Mountain. Occasionally bears have been known to break into closed camps and rob the larder.

Each year trappers get the marten, fisher, mink, otter, lynx and red fox. In the fall of 1926 beavers were trapped about two miles up a small brook at Red Camp. When I visited the spot, the colony had evidently been exterminated and the dam washed away by spring floods.

During my stay on the Cascapedia River, bird life, with the exception of water birds, was scarce. Kingfishers, mergansers, yellow-legs and small waders were common. Numbers of fish-hawks patrolled the lower river, and natives assure me that sometimes these birds fasten onto a salmon and are drowned. Other species of hawks were rarely seen. Grouse, usually quite plentiful, seemed to have almost disappeared. A pair of Canada jays were seen at Berry Mountain and four or five three-toed woodpeckers along the trail. In the forest I saw a few small flocks of brilliantly colored birds, crossbills, warblers and finches; a pair of ruby-throated hummingbirds visited the flower garden at Red Camp every day while I remained there.

Condylura cristata (Linnaeus).—Star-nosed Mole. One specimen: New Derreen. This is the only known species of mole inhabiting the Gaspé Peninsula. The specimen taken was trapped under an old tree stump in a marshy meadow. Possibly this species is quite common in the lower valley, but I did not see any signs of its presence.

Sorex cinereus cinereus Kerr.—Masked Shrew. Forty specimens: Red Camp,

5; New Derreen, 3; Middle Camp, 8; Big Berry Mountain, 24. The variation in the abundance of this shrew at different camps was very noticeable. It was quite rare in the lower Cascapedia Valley; at Middle Camp *cinereus* came to the traps quite frequently; beyond Big Berry Mountain it was extremely abundant, both in the forest and in the clearings along the river.

A shrew hunting for food on an old moss-covered stump allowed me to approach within a few inches. Apparently unaware of my presence it made a thorough search for food from end to end of the stump. It moved with a quick jerky motion, without pausing even to devour the insects captured. Its sense of direction seemed to reside in its nose, which was thrust into every nook and corner.

Sorex fumeus umbrosus Jackson.—Northern Smoky Shrew. Twelve specimens: New Derreen, 1; Middle Camp, 11. The smoky shrew was found in the deep spruce forest, where it lived under old moss-covered logs or in the holes between the loose rocks. *Fumeus* appeared to be very local. The twelve specimens taken, with the exception of one example, were all trapped within an area of about 500 yards that during a freshet was completely covered with water. One female was nursing, and individuals of both sexes had tails swollen twice the normal size.

Sorex gaspensis Anthony and Goodwin.—Gaspé Shrew. Nine specimens: Red Camp, 6; New Derreen, 1; Middle Camp, 1; Big Berry Mountain, 1. This slender little shrew is an inhabitant of the swift mountain streams, in the deep spruce of the Gaspé Peninsula. Though nine specimens were secured, I do not consider it at all common. *Gaspensis* is not easy to catch, and a day or two of intensive trapping in almost inaccessible places was required to collect one or two specimens. It was usually taken in dark holes under the overhanging banks of small streams, or at the foot of waterfalls between the boulders, and was apparently living under the same conditions as the water-shrew.

Sorex palustris gloveralleni Jackson.—Nova Scotia Water-shrew. Three specimens: Red Camp, 2; Middle Camp, 1. Water-shrews were not common in this region; the three examples were taken in traps set in runways at the side of waterfalls and around huge boulders on small swift mountain streams. Two of the specimens apparently blundered into the traps, and the third was attracted by the bait. All three specimens showed signs of the moult and one had shed about half its coat.

Microsorex hoyi intervectus Jackson.—Pigmy Shrew. One specimen: Big Berry Mountain. Though shrews in general were quite plentiful, the pigmy shrew was conspicuous by its scarcity. The one specimen was trapped in the forest in the runway of a red-backed mouse.

Blarina brevicauda talpoides (Gapper).—Short-tailed Shrew. Six specimens: Red Camp, 3; New Derreen, 1; Middle Camp, 1; Berry Mountain Brook, 1. The genus *Blarina* was thinly distributed throughout this district. Traps set in ideal haunts for it yielded only a very limited number of specimens. The six examples were taken in *Clethrionomys* runways, under moss-covered logs along the river bank, and under piles of dead brush at the sides of the trail. *Blarina* was usually taken during the night in traps baited with fresh meat.

Myotis lucifugus lucifugus (Le Conte).—Little Brown Bat. Nineteen specimens: Middle Camp. This bat was quite common in the Cascapedia Valley.

Every evening one or two of them were seen at dusk skimming along the river and occasionally touching the surface of the water. During the cold days in August and September *lucifugus* was found roosting behind the chimney stacks at the camps.

Myotis keenii septentrionalis (Trouessart).—Trouessart's Little Brown Bat. One specimen: New Derreen. Bats were difficult to obtain in the forest, and several specimens that were shot fell into the brush and were lost. The one individual of this species taken was found between the chimney and walls of a fishing camp.

Mustela cicognanii cicognanii Bonaparte.—Bonaparte's Weasel. Three specimens: Middle Camp, 2; Berry Mountain Brook, 1. Weasels were comparatively rare in the Cascapedia Valley. The first specimen was taken in a trap baited with red squirrel, the second in a trap set on a narrow path through the forest, and the third in a trap baited with fresh fish.

Mustela vison vison Schreber.—Eastern Mink. Two specimens: Middle Camp. Minks are not uncommon on the Cascapedia River in spite of the fact that they are rigorously hunted during the open season. Both specimens were trapped on a good mink trail along the bank of a deep salmon pool. They are small and dark, extreme forms of the northeastern subspecies, true *vison*.

Mephitis mephitis (Schreber).—Canada Skunk. One specimen: Middle Camp, skin without skull. This is the northern short-tailed form and is apparently uncommon in the Cascapedia Valley. My guide told me that a few years ago a family of skunks lived under a shed at Berry Mountain, and that one was occasionally seen at the village (Grand Cascapedia).

Peromyscus maniculatus abietorum (Bangs).—Nova Scotia White-footed Mouse. Forty-four specimens: Red Camp, 7; New Derreen, 11; Middle Camp, 16; Big Berry Mountain, 10. White-footed mice were abundant in the Cascapedia Valley. They were, however, commoner in the forest than in the open country of the lower valley. Specimens were taken only during the night.

Clethrionomys gapperi gapperi (Vigors).—Red-backed Mouse. Sixty-eight specimens: Red Camp, 17; New Derreen, 9; Middle Camp, 19; Big Berry Mountain, 23. Average measurements of twenty largest specimens: total length, 145.5 mm.; tail vertebrae, 42.3 mm.; hind foot, 19.5 mm. *Clethrionomys*, the commonest mouse of the region, was found everywhere. While walking in the forest I occasionally saw them cross my path in the bright sunlight. They were trapped at all hours of both day and night. Several females had six large embryos each and one unusually large specimen had eight embryos.

The red-backed mouse of the Gaspé Peninsula is slightly larger than typical *gapperi*. The series taken has a wide range of individual color variations, both in the normal red pelage and in the dichromatic phase. Some of the lightest of the red-backed specimens approach the dull rusty rufous of *ochraceus*, while others are even a deeper red than *gapperi*. The dusky-backed individuals are in the small minority, varying in color of dorsal stripe from dark mouse grey to a dull yellowish brown. Immature specimens of both phases are represented in the collection.

Microtus pennsylvanicus fontigenus (Bangs).—Forest Meadow Mouse. Thirty-eight specimens: Red Camp, 14; New Derreen, 2; Middle Camp, 16; Big Berry Mountain, 6. The meadow mouse is common in all suitable places throughout

this region. It was found living in clearings around the camps, but was especially abundant in damp places where the grass had sprung up. Runways were very indistinct, usually littered with a few freshly cut grass stems. *Microtus* was a frequent visitor to the camp kitchens in broad daylight and showed little fear of man.

I have listed this series of specimens as the northern form of meadow mouse, *fontigenus*. I do not consider them typical, but they are rather closer to *fontigenus* than *acadicus* or typical *pennsylvanicus*. There is a marked variation in the characters of the skulls and in the color and measurements of the skins.

Microtus chrotorrhinus chrotorrhinus (Miller).—Rock Vole. Ten specimens: New Derreen, 2; Big Berry Mountain, 8. Average measurements of four adult specimens: total length, 154.25 mm.; tail vertebrae, 42.5 mm.; hind foot, 20.8 mm.

This interesting little inhabitant of the forest was not common. It was, however, easy to trap and appeared to be very local. Six of the individuals in the series were all found in one small clearing in the forest, on a sunny hillside where a few trees had been cut and the ferns, violets and other plants flourished. Two other specimens were taken in a similar locality on an old camp-site at the side of the trail. *Chrotorrhinus* is apparently wholly diurnal. I visited my traps three times each day, once in the early morning, once at noon, and again at five o'clock. I generally found *chrotorrhinus* in the traps during my noon-day visit, and at this time they were usually still warm. Occasionally I got them on an evening trip and then they were quite cold. On wet or cloudy days the rock vole stayed at home. The runways of *chrotorrhinus* were very indistinct and nowhere did I find them littered with cuttings of green stuff like those of *pennsylvanicus*. The presence of this vole, however, was indicated by little piles of partly eaten stems and leaves of plants, dragged under old logs and into holes between the rock. The greater part of these fragments were leaves and stems of false miterwort (*Tiarella cordifolia*), and a small percentage was cuttings of violet (*Viola incognita*), bunchberry (*Chamaeperichimeum canadense*) and a mayflower (*Unifolium canadense*). Five immature specimens about two weeks old and all of the same litter were taken within a radius of three yards. An old male and a female, possibly the parents, were also taken in the same spot. The female had four large embryos in the uterus and was still nursing a previous litter. Another female taken a short distance away had four very small embryos.

This small series of rock voles appears in every way to be typical *chrotorrhinus*. The largest specimen has a little longer hind foot (21 mm.) than the type (19.4 mm.) and the skull is a fraction larger, but this may be due to age. In color they appear to be typical. The four adult specimens show some individual variation. An old male and female have the roufus nose patches much brighter and larger than the other two, and the female is noticeably paler on the back than the male. The young are slightly greyer than the adults, with nose patches distinctly marked, but paler.

Ondatra zibethica zibethica (Linnaeus).—Muskrat. One specimen: Lazy Bogan, Big Berry Mountain. Muskrats were numerous on the Cascapedia River. They seem confined to the bogans and backwaters of the river, where they live in holes under the banks.

Zapus hudsonius hudsonius (Zimmermann).—Hudson Bay Jumping Mouse. One specimen: Middle Camp. The Hudsonian jumping mouse was apparently

very scarce this season. In the harvest fields, where it is usually quite common, I did not find a single specimen. The one individual was taken in a small grass-covered clearing in the forest.

Napaeozapus insignis insignis (Miller).—Woodland Jumping Mouse. Fifty-seven specimens: Red Camp, 29; New Derreen, 7; Middle Camp, 21. Average measurements of ten specimens: total length, 238.4 mm.; tail vertebrae, 146.9 mm.; hind foot, 31.6 mm. The woodland jumping mouse was common at most places visited in the Cascapedia Valley. It was usually taken alongthe banks of cool mountain streams in the dense evergreen forest. I did not find *insignis* at Big Berry Mountain and several days persistent trapping in suitable places did not yield a single specimen.

All of the fifty-seven specimens are mature with the exception of two half-grown young. Compared with a series of thirty examples of *insignis* from Berlin, New York, the measurements average slightly larger, and the color of the dorsal stripe is a shade darker and more sharply defined. The Gaspé specimens, however, have the wide, stout skull with the broad interorbital constriction of typical *insignis*.

Erethizon dorsatum dorsatum (Linnaeus).—Canada Porcupine. Two specimens: Big Berry Mountain, 1; Middle Camp, 1. Porcupines were plentiful in the Cascapedia Valley, and almost every lumber camp I visited had sections of the floors or doors gnawed by these animals. Well worn porcupine trails leading from the various camps into the forest were common. A young porcupine about two weeks old was caught on the trail, one bright sunny morning. The youngster soon became tame and seemed fond of fresh green shoots from various deciduous trees. It spent most of the day on the lawn picking green clover leaves and eating them.

Marmota monax canadensis (Erxleben).—Canada Woodchuck. One specimen: Big Berry Mountain. Woodchucks' burrows were common in the lower valley, but I saw only a very few of these animals. The one specimen, an immature male, was trapped under an old lumber camp.

Tamias striatus griseus Mearns.—Grey Eastern Chipmunk. Eight specimens: Red Camp, 4; Middle Camp, 3; New Derreen, 1. Average measurements of seven specimens: total length, 246.7 mm.; tail vertebrae, 94 mm.; hind foot, 36 mm. Chipmunks were common everywhere along the banks of the river, and in the open farm country near the coast. The small series taken are very interesting, being examples of the big grey chipmunk found in Minnesota. They are decidedly larger than *lysteri* and have the grizzled appearance of typical *griseus*. One particularly large old male measured in the flesh: total length, 250 mm.; tail vertebrae, 95 mm.; hind foot, 38 mm.

Sciurus hudsonicus gymnicus Bangs.—Bangs' Red Squirrel. Ten specimens: Red Camp, 5; Middle Camp, 3; Big Berry Mountain, 2. Average measurements of ten specimens: total length, 268.3 mm.; tail vertebrae, 109.6 mm.; hind foot, 45.2 mm. The red squirrel was very common almost everywhere. Its shrill cry was usually the first sound that greeted one on entering the forest in the morning. All the way along the trail from Red Camp to Big Berry Mountain red squirrels were constantly heard and seen. They proved, however, to be the usual nuisance by getting into many of my traps not set for them. This is the smallest of the eastern red squirrels.

Glaucomys sabrinus sabrinus (Shaw).—Hudson Bay Flying Squirrel. One specimen: Middle Camp. Flying squirrels are not uncommon in the Cascapedia Valley and at times many are taken by trappers. I did not find them very plentiful, although I was on the lookout for them in suitable places. The one individual, an immature specimen, was taken in a large mouse trap baited with bacon and set at the foot of a spruce tree.

Lepus americanus struthopus Bangs.—Nova Scotia Varying Hare. One specimen: Square Forks (on the trail between Middle Camp and Big Berry Mountain). Hares, usually very abundant in this region, were quite rare. I saw only the one specimen during the two months that I was in Canada.

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NOTES ON SOME MAMMALS OF ALLEGANY STATE PARK

By W. J. Schoonmaker

This brief account of the mammals in Allegany State Park, New York, is the result of a very short visit to that locality. Only fourteen days, August 20 to September 2, 1926, were spent in the park by the author and for that reason the observations are very limited.

In that area in Cattaraugus County, New York, inclosed by the great loop of the Allegheny River, lies Allegany State Park. The river itself is not the boundary of the park because the Allegheny Indian Reservation extends along the river approximately a half-mile on either side. With the exception of a small area, Tunungwant Creek borders the park on the southeast side and the state of Pennsylvania forms the extreme southern boundary.

In general, the park area consists of rather low mountains. These are wooded to their very tops, mostly by deciduous trees. The greater part of the park is in a wild state, and all except the larger valleys are well forested. In these larger valleys, there are numerous farms and the land is under cultivation.

Although the highest elevation within the park is only about 2,500 feet, the area is interesting in the sense that some of its flora and fauna are characteristic of the Canadian zone and, with the exception of part of Long Island, it is the only area in the state that has not been glaciated.

Condylura cristata—Star-nosed Mole. Wm. P. Alexander has taken the star-nosed mole in the years 1921, 1922, and 1923, and I found the work of the animal in the soft, damp earth at the west end of Buffalo Camp in 1926.

Parascalops breweri—Hairy-tailed Mole. Wm. P. Alexander reported that one was taken during the summer of 1927.

Blarina brevicauda brevicauda—Short-tailed Shrew. Occurs nearly everywhere; in forests, in old fields, and along grassy banks. They are particularly partial to wet or moist situations and apparently drink rather frequently. With the exception of the white-footed mouse, I caught more of this species in my traps than anything else. One was taken in an old orchard near Willis Run, another along Coon Run, some on the side of Seneca Mountain, and some in the lowlands near Buffalo Camp.

Sorex fumeus fumeus—Smoky Shrew. I took specimens on the sparsely wooded hillside behind Buffalo Camp and in the rather open woods along Coon Run.

Myotis lucifugus lucifugus—Little Brown Bat. Dr. S. C. Bishop secured two of these bats near Freeks in Allegany State Park in August, 1926.

Lynx rufus rufus—Wild Cat. A. A. Saunders reports that tracks of this creature were recorded along the streams in the Big Basin with other tracks of the larger mammals, and Wm. P. Alexander said that one night during the summer of 1921 the campers at Buffalo Camp were frightened by two of these large cats fighting.

Vulpes fulva—Red Fox. Red foxes are found throughout the park and A. A. Saunders has recorded tracks in Big Basin.

Mustela vison mink—Mink. The mink is generally distributed throughout the park and I found its tracks along Coon and Quaker runs. A. A. Saunders also reported the mink in the park in 1922.

Mustela cicognanii cicognanii—Small Brown Weasel. John Hofmayr killed one near Buffalo Camp.

Mephitis nigra—Skunk. Common within the park and often wanders into the various camps, much to the annoyance of the campers.

Procyon lotor—Raccoon. In the park this mammal is rather abundant, and in 1924 ninety were taken by hunters and trappers. The distribution of the animal throughout the park makes it possible to find the tracks along every water course. Some tracks showed along Tunungwant Creek but not nearly so plentifully as in other places within the park. Along Quaker Run, from Allegheny River to the point where the main road crosses the creek, many tracks of raccoons were observed. Crawfish, one of the chief items of food of raccoons, were very plentiful in this stream and from the remains found along the shore it was evident that the 'coons were successful in their hunting.

Euarctos americanus americanus—Black Bear. Wm. P. Alexander saw one cross the road just below Buffalo Camp in 1921, and John Hofmayr saw a large one near Camp Turner on October 10, 1926, at 7:45 a.m.

In the sphagnum bog between Buffalo Camp and Bradford, Pennsylvania, there were plenty of signs of bears. The ferns and grasses were trampled down, and the shadbushes were bent and broken by the bears so that they could reach the berries. Large logs were torn apart, and stumps, so solid that a man could not push them open, were ripped open by the bears in search of carpenter ants.

Accordng to E. W. Countryman, a bear, which had been killing sheep in that locality, was destroyed and the skull, which I had the opportunity to examine, was preserved by Mr. Countryman.

Odocoileus virginianus borealis—Virginia Deer. Abundant within the park area and its tracks may be found in the lowlands along the streams and on the very

highest points. I recorded a doe and a fawn in the Tunungwant Creek valley, August 22.

Sciurus hudsonicus loquax—Red Squirrel. The red squirrel does not appear to be numerous in the park although it may be found in mixed woods, especially where the coniferous trees are plentiful. I found the remains of cones which had been scattered about by red squirrels on the side and near the top of Seneca Mountain and also on the top of Cayuga Mountain. While working along Coon Run I heard the chatter of two red squirrels in different parts of the forest, and Dr. S. C. Bishop saw one scampering through the woods as he went along the road near Coon Run.

Sciurus carolinensis leucotis—Gray Squirrel. According to Wm. P. Alexander, gray squirrels are more plentiful in the park than red squirrels. A. A. Saunders records the black color phase as being the most likely animal to be seen in the forest of the Big Basin.

Tamias striatus lysteri—Chipmunk. Chipmunks are very numerous within the boundaries of the park and every camp that I visited had its chipmunk population.

Marmota monax rufescens—Woodchuck. Though common in the park, the woodchuck is not so numerous as in other parts of the state. I found two woodchuck dens about half-way up Seneca Mountain and one on the side of Cayuga Mountain. On August 25, 1926, we saw a woodchuck in the woods that surrounds the sphagnum bog and three days before that we saw one in the very midst of Buffalo Camp. A few miles below the park headquarters there are some open hillsides and here, on August 23, we saw one feeding.

Glaucomys volans volans—Flying Squirrel. More plentiful in the park than is generally believed, but because of its nocturnal habits it is seldom seen. In 1922, Wm. P. Alexander found the nest of a flying squirrel about six feet from the ground in a large witchhazel. It was made almost exclusively from the inner bark of basswood.

Mus musculus—House Mouse. Recorded only at the Buffalo Camp restaurant.

Rattus norvegicus—House Rat. This familiar rodent is said to have been seen at the Buffalo Camp restaurant, and this is the only record we have of it occurring in the park.

Peromyscus maniculatus gracilis—Canadian White-footed Mouse. One of the most abundant mammals in the park. Specimens were taken in the lowlands near Buffalo Camp, on Coon Run, on the side and top of Seneca Mountain, and on the very top of Cayuga Mountain.

Ondatra zibethica zibethica—Muskrat. The muskrat is found within the park area but sparingly as far as recent observation can ascertain. Seventy of these animals were reported to have been trapped in 1924. The only tracks I found were along Quaker Run.

Microtus pennsylvanicus pennsylvanicus—Field Mouse. I found the field mouse near the base of Seneca Mountain and saw tracks in several other localities. Clarence Wagner turned over a board in a very open woods near Frecks and five of these mice were hiding under it. Dr. S. C. Bishop ran over a large male as it tried to cross the road near the sphagnum bog on the Bradford road.

Clethrionomys gapperi gapperi—Red-backed Mouse. The red-backed mouse is found within the park area although not so abundantly as some of the other

mice. Half of the specimens that I took were captured on the bank of a stream. Two were taken on Slide Hollow Brook, one near the top of Seneca Mountain and one at the base. Another was taken on Coon Run.

Napaeozapus insignis insignis—Jumping Mouse. More or less abundant within the park, though it confines itself to the deep woodlands particularly in the vicinity of running water. Dr. S. C. Bishop and Wm. P. Alexander observed them in the low, damp woods behind the spring at Buffalo Camp, and I found them in the wet lowlands bordering Quaker Run at the same camp.

Erethizon dorsatum dorsatum—Porcupine. Apparently evenly distributed throughout the park. I found their workings near the sphagnum bog, on the top of Cayuga Mountain, on the side of Seneca Mountain, in the Bear Cave, and in August, 1926, a trail guide killed one near Buffalo Camp.

Lepus americanus virginianus—Varying Hare. According to John Hofmayr, who is in the park from spring until winter, the varying hare is often found near Buffalo Camp and he has killed them while he was hunting in that locality. It was reported that 165 snow-shoe rabbits were killed in 1924 within the park by hunters.

Sylvilagus floridanus mearnsii—Cottontail. Dr. S. C. Bishop saw a cottontail in the Red House Valley and later he found one which had been killed by an auto near the dam. John Hofmayr has seen them hopping about the streets of Buffalo Camp after the campers had left. According to the reports of 1924 there were 138 cottontails killed in the park.

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GENERAL NOTES

OPOSSUM IN THE LOWER HUDSON VALLEY, NEW YORK

On the morning of June 27, 1928, after crossing the Hudson River over Bear Mountain Bridge, and proceeding to the top of the long incline on the Peekskill side of the river, I was considerably surprised to observe an opossum (*Didelphis virginiana virginiana* Kerr) lying dead on the right-hand edge of the concrete roadway where it had probably been killed by a passing automobile. The unlucky individual, judged by the size of our South Carolina opossums, was about one-third grown. My car passed within a foot or two of its body at about fifteen miles an hour. His grinning jaws, and long, stout, hairless tail made the identification positive. My passionate desire was to take it and preserve the skin and skull, but the heavy traffic at the time made this impossible. Miller (North American Recent Mammals, 1923) gives as the northern boundary of the range of this species as the lower Hudson valley. This record may, consequently, be of some interest to mammalogists. On the other hand, of course, the specimen may have been merely an escaped pet.—Robert H. Coleman, *4 Green Street, Charleston, South Carolina.*

SOREX FONTINALIS ON THE EASTERN SHORE OF MARYLAND

Doctor Wetmore's note (Journ. Mammalogy, vol. 9, p. 247) regarding the distribution of *Sorex fontinalis* prompts me to place on record the occurrence of this species in numbers on the east side of the Chesapeake Bay near Cambridge, Maryland, where I have collected fifteen specimens. In this region sphagnum is common, some lowland tracts of timber having the floor almost entirely covered with it. All of the above mentioned specimens were collected in a small tract of mixed timber with small patches of sphagnum in the low places. Most of these specimens were collected during the winter months when I found them quite active on warm damp nights after cold spells of weather. I have never been able to collect this species in freezing weather, though I have taken *Blarina brevicauda talpoides* and *Cryptotis parva* when the temperature was well below the freezing point. Salt meat and cheese were used as bait, and the latter seemed very attractive. Some of the specimens are in the U. S. Biological Survey collection and have been determined by Dr. H. H. T. Jackson.—Ralph W. Jackson, *Route No. 1, Cambridge, Maryland.*

BEHAVIOR OF THE LEAST SHREW

About 5:45 p.m., March 6, 1928, this museum received a live adult male least shrew, *Cryptotis parva,* taken on James Island, near Charleston, S. C. The little animal was brought in a can eight inches in diameter, with six inches of soft earth in the bottom. The shrew was quite active, running about and stopping quickly in a nervous manner, sometimes with the snout elevated and sniffing the air. The body was usually carried much humped and shortened, with the small feet barely visible. The tail lay flat to the ground.

At times, during its rounds of the can, the shrew would stop and dig. Most of the holes dug were shallow, not exceeding one-half to three-quarters of an inch in depth, at which depth they were abandoned and digging begun at another place.

Four such holes were dug and another one carried down until the body of the animal was almost concealed. In going down, the shrew would commence by rooting about with the snout, then he would dig rapidly with the fore feet, throwing the dirt out after the manner of a dog. Occasionally the hind feet would flash out as an aid in clearing away some of the earth accumulating beneath the body. On getting down half the body length, the shrew would twist its body so as to facilitate digging to the right, then to the left, and once almost overhead. Here again one thought of the actions of a small terrier in digging out a rat. This hole, about three-quarters of an inch in diameter, was abandoned in the same quick, jerky manner as had been the shallow ones.

Interrupting the digging, I placed a baked bean near the shrew, and although he nibbled about half the bean and ate a like amount of mashed white potato, he evinced no particular interest in this food. However, on my placing an earwig before him he rapidly ate it. The next item was a pill-bug, which was seized viciously, considerably mangled, and eaten. The soft parts were consumed first. Another pill-bug suffered a like fate, as did a smooth caterpillar, about three-quarters of an inch in length by three-sixteenths in diameter. Following this, a rather large grub, an inch and a quarter long by five-sixteenths in diameter, was placed near the shrew and the animal pounced upon it immediately, attacking the head first. Then he ran about the grub, biting it in different places, finally coming back to the head, where eating commenced. The grub's resistance to all this took the form of twisting and turning, which seemed to discourage the little mammal not at all. While worrying and eating the grub, the shrew allowed me to run my hand just below the earth and pick him up, grub and all. Once or twice he slid off my hand, but always held on to his victim.

After placing two more grubs just below the soil in the can, I found it necessary to leave, at 6:30, while the shrew was still engaged with the first grub. At nine the next morning, I found the shrew dead beneath some leaves and moss, placed in the can the evening before. The two reserve grubs had not been touched, perhaps because they had worked down to a depth of three or four inches. On skinning the shrew, I found two slight bruises on the lower back, hardly severe enough to have contributed to the cause of its death.—E. B. Chamberlain, *Charleston Museum, Charleston, South Carolina.*

THE LEAST WEASEL, MUSTELA ALLEGHENIENSIS, IN ILLINOIS

Probably the first record of a least weasel in Illinois is that of one taken February 3, 1925, in Highland Park, Lake County, and now mounted in the Elm Place Grammar School in that town. Jesse L. Smith, the school superintendent, said that it was caught in a house about two blocks from the center of the business section of the town. Concerning its capture he writes "about nine o'clock that evening Mrs. Noerenberg phoned me that there was a strange little animal in their house and that it had probably been there two or three days. She thought that it was a mole or some such animal, and added that it smelled disagreeably. I hurried across the street to their house, and took charge of the hunt. We pulled all the furniture in the living room away from the wall and soon found the animal dodging about for a hiding place. It finally ran up a roll top desk and crouched in the cavity where the desk lid coils up. We unscrewed the top of the desk, and when the animal jumped to the floor, I clapped a steel waste-basket with a small

mesh, over it. The little animal fought desperately to get out. It would run around and dash itself against the wires and fall exhausted on the floor. After it would recover, it would begin all over again. After a last great effort, it gasped its last. It had committed suicide."

A second specimen was killed by Robert Haire, on September 30, 1927, at the home of Mr. Gregory's brother in Northfield Township, Cook County, Illinois. It had apparently fallen through a grating over an area by a cellar window and was unable to get out. Mr. Gregory did not secure the specimen until two or three days later, when it was so badly decomposed that the skin could not be saved. The skull, which had not been damaged, he presented to Field Museum of Natural History, Chicago.

Another specimen was sent to Field Museum by the Conservation Department of Northern Illinois, they having received it from one of their game wardens. Through the warden, Mr. Sanborn received a letter from the trapper, Lorin J. de Woody, who writes, "I caught the weasel January 10 [1928], in a steel trap, north of Waukegan about three miles (Beach, Ill.), and one and one-half miles west of Dead River. I have caught five of them this winter in bait-sets for mink. I never saw any around here before."—TAPPAN GREGORY AND COLIN CAMPBELL SANBORN, *Chicago, Illinois.*

THE ALLEGHENIAN LEAST WEASEL IN PENNSYLVANIA

Record of weasels upon which bounty was paid in Pennsylvania has been kept since the inception of the Bureau of Predatory Animal Control of the State Game Commission in April, 1915. Between April 1, 1915, and March 1, 1929, bounty was paid from the office of the Game Commission at Harrisburg upon 608,688 weasels.[1] Among the pelts or bodies sent in were a few of the least weasel, *Mustela rixosa allegheniensis* (Rhoads). Prior to 1925, no record was kept concerning the source of these interesting mammals. Since November, 1925, however, accurate records have been kept, and eighty-seven pelts have been examined, one animal in a trap seen, and one free live animal noted. Several of the flat skull-less pelts secured in 1925 and 1926 were forwarded to the Bureau of Biological Survey in Washington.

On the accompanying map (fig. 1) are indicated the localities where specimens were taken or individuals recorded. It will be noted at once that there has been little tendency during recent years toward extension of the known range of the species to the eastward of the Allegheny Mountains, though records in the mountainous district may indicate such a tendency. It appears to be widely distributed to the westward of the mountains. Specimens were taken at all seasons of the year, though most of them were trapped in January and February. A large proportion of the animals were taken in agricultural districts.

It is notable that but four of these specimens were white, and these were the only specimens that showed even a tendency toward a recognizable change of pelage. All of these individuals were altogether white, save one which had a black-tipped tail. It seems to me remarkable that specimens received during the winter months, from October to March, should show no tendency toward mottled

[1] Prior to April, 1915, bounty payments were made by county officials, and these records are not readily available here.

coloration. On February 3, 1914, J. L. Randall took one in white pelage near Pittsburgh, Allegheny County. On January 15, 1928, at Keating Summit, Potter County, Jean Alden caught one in pure white pelage, near a small stream. On January 16, 1928, Austin Diehl secured a pure white individual near Bedford, Bedford County. On February 21, 1929, J. S. Tremmel caught three specimens in Washington County, one of which was white with a black-tipped tail.[2]

Among adult individuals supposedly in summer pelage, little variation in the shade of brown of the upper parts was to be noted. Adult animals were, as a rule, lighter and browner than the young. On December 24, 1927, at West Middletown, Washington County, George M. Kelley took five full-sized, though young, animals all with handsome dark brown backs, white underparts, and very short slender tails, the narrow short-haired tips of which indicated immaturity. These animals

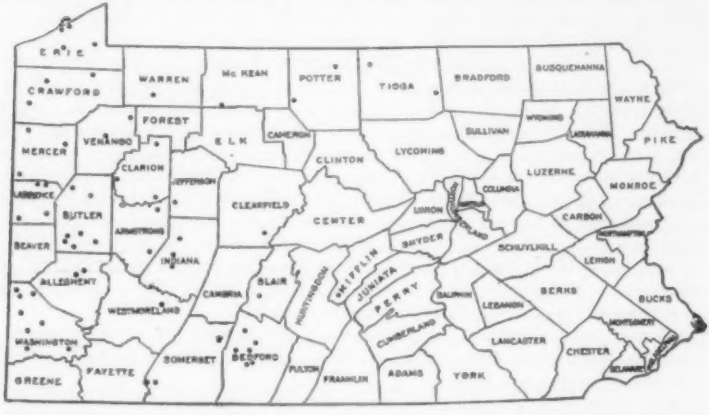

FIG. 1. DISTRIBUTION OF MUSTELA RIXOSA ALLEGHENIENSIS IN PENNSYLVANIA

were caught under the same pile of corn fodder, so it is presumed they were members of the same family; I believe that they were about two months old. This series is virtually topotypical.[3]

A specimen taken December 8, 1927, at Erie, Erie County, evidently an adult, was much lighter brown above than the five juveniles taken in Washington County

[2] This specimen (a flat skin) was identified as of this form by Dr. Hartley H. T. Jackson, of Washington, D. C. I had entertained considerable doubt about the status of the animal because of the black-tipped tail. The tip of the tail of this specimen was decidedly black, not brownish. This black tip, however, was small and consisted of only a comparatively few hairs.

[3] The type of this form, named by Samuel N. Rhoads, was taken at Beallsville, Washington County, Pennsylvania (Proc. Acad. Nat. Sci., Philadelphia, 1901, p. 751).

referred to above. On October 27, 1928, R. H. Andrews took four specimens near Swissvale, Allegheny County, two adult, and two immature. The younger animals were noticeably darker. On January 14, 1929, Walter McKinley took five specimens near Bedford, Bedford County. These were probably members of the same brood, but all apparently had attained mature pelage; at least all were rich, solid brown above. We do not know the customary date of birth of the young, but our records tend to indicate that they may appear at any season of the year.

On January 15, 1929, Steven Karode took four small young from a nest not far from Burgettstown, Washington County. These were dark gray-brown above and grayish white below, the whitish area faintly suffused with buffy or silken yellow. The fur of these young animals was glossy. The female parent, taken at the same time, was about normal in coloration, the brown of the upper parts being a trifle pale and not lustrous, due, perhaps, to wear and fading attendant upon the duties of motherhood.

We have not yet examined enough specimens, of course, to make certain that fully adult individuals ordinarily retain their brown coat during winter in Pennsylvania. Most of our least weasels apparently do not change, though whether this is the result of our securing a large percentage of sub-adult animals which may moult later in the season, later in life, or more irregularly than the adults, it is impossible at present to say. Seasonal changes in fur do not appear to cause an appreciable change in the color of the individual. Perhaps the individuals that do become white in winter moult so rapidly that the transitional stages are rarely observed. John J. Slautterback,[4] for many years chief of the Bureau of Predatory Animal Control of the Game Commission, states that in his many years of experience he has never seen a least weasel alive or dead whose upper parts were partly white and partly brown.

We have learned but little concerning the local food habits of this small weasel, since specimens in the flesh are only rarely sent in, and we have not had a living individual in captivity.

We do have data, however, concerning the nest found by Steven Karode, near Burgettstown, Washington County (referred to above). As Mr. Karode was going through a meadow on the rainy morning of January 15, 1929, following his trap line, he saw a weasel running along a small stream. The animal popped into a small hole in the bank. This hole was not deep. After Mr. Karode had dug about six inches into the bank he saw the weasel. Back of the animal the hole, which turned suddenly downward, was full of water. Having killed the weasel, which proved to be a female nursing young, he examined the tunnel farther, and found a chamber to the side which was filled with dead grass. Here were four young animals, their eyes not yet opened. The nest was about four feet from the edge of the stream and not far below the crest of the low bank. The young were carried home alive.

The young animals taken by Mr. Karode (flat skins at hand) were apparently about half-developed. Their tails are very short and slender and the hair covering them is short and soft. The pelts measure about five inches from tip of nose to tip of tail.—George Miksch Sutton, *Game Commission, Harrisburg, Pennsylvania.*

[4] Mr. Slautterback is now executive secretary of the Game Commission.

CANIS LATRANS LESTES MERRIAM FEEDING ON TADPOLES AND FROGS

Between 9 and 10 o'clock on the morning of July 21, 1928, from an elevation of about 11,900 feet on the rim of Humphrey Basin in the Sierra Nevadas west of Bishop, California, the writer and a companion had an excellent opportunity to observe a curious feeding habit of the big coyote frequenting the higher elevations of these mountains. Below us at a distance of about 250 yards lay a small shallow pond with a sand beach on the far side. Our attention was at once attracted by a large coyote moving impatiently up and down the beach. Its every movement was plainly visible through our field glasses. Soon after our arrival the coyote waded into the shallow water and made several plunging snaps into it and then returned to the beach where it again began a search for something along the water's edge. It entered the water three times always snapping at something invisible to us in it and thrusting its head half under each time. When coming out it shook itself to get rid of the water on its fur, like a dog. After nearly 15 minutes of this the coyote appeared to become uneasy and left for other parts.

Our examination of the pond where the coyote had been feeding, and others in the neighborhood, showed them to be filled with masses of tadpoles of the Sierra yellow-legged frog (*Rana boylii sierra*). They were so abundant that they caused the water fairly to boil as they sought safety in the deeper parts on our approach. Most of these tadpoles were so large they appeared to be the last of the preceding summer's hatch which had remained in the larval stage through the winter. The adult frogs were found very sparingly around the shores. As no signs of other available animal life could be found in or about the ponds we were forced to the conclusion that the frogs and their young were the objects of the coyote's pursuit.—Robert D. Moore, *Redlands, California.*

BEAVERS RESUME EARLIER WORK

For about ten years I have been studying a small colony of beavers on a little stream running into the Ottawa River near Arnprior, Ontario, and some observations bearing on notes in the Journal of Mammalogy for August, 1928, may be of interest.

William A. Harlow (Journ. Mammalogy, vol. 9, p. 252) writes of beavers resuming earlier work in felling a tree. This is not unusual for beavers to do provided the tree is still alive, as it was in the case cited by Mr. Harlow. For instance, the largest tree my beavers have felled, a poplar 22 inches in diameter at the cut and 70 feet high, was first eaten into November 5 to 12, 1922, and the work then abandoned. The cut was not deep enough to kill the tree and it leafed out as usual in the summer of 1923. Work on it began again in October of that year, and it was finally brought down about the first of November. Incidentally, it fell inshore in a very thick place, and the beavers never touched it again.

In another instance, a white ash which had been gnawed into a little on one side was killed by the water held back by a dam. It was manifestly dead and dry on April 3, 1927, but apparently beavers do not believe their eyes in such cases, and one of them came along that day, and took a few more bites out of the tree before he was satisfied that it was really dead.

The only dry wood I have ever seen the beavers cutting were fallen pieces they cleared from the roads along which they convey wood to their ponds. I have never noticed them felling a dry standing tree.

Edward R. Warren records extensive cutting of scrub oak by beavers. The beavers here some years ago cut down the only two red oaks in the vicinity of their ponds. They were three or four inches in diameter at the stump. I do not know what they did with the trees, as I found only the stumps and a heap of the smallest beaver chips I had ever seen. It was the small size of the chips that first drew my attention to the cutting. Gnawing oak is evidently hard work even for a beaver. An abundant supply of their favorite poplar was available and was being cut by them at the time.—CHARLES MACNAMARA, *Arnprior, Ontario, Canada.*

AN INTERESTING ANOMALY IN PEROMYSCUS

On August 29, 1928, I skinned a mouse which at first glance appeared to me to have a large warble under the skin of the back. It was shortly apparent, however, that the unusual protuberance was the caecum, which, fairly well filled with caecal material, had a position outside the body, where it extended from just posterior to the ribs up to the occiput. The accompanying sketch (fig. 1) of the skinned body illustrates the situation; the mouse carried the caecum as though it were a small pack on its shoulder.

FIG. 1. SKETCH OF THE SKINNED BODY OF A PEROMYSCUS MANICULATUS SHOWING AN EXTERNAL CAECUM. ABOUT $\frac{1}{2}\times$

The mouse was a female with a body length of 94.6 mm. This body length, combined with the appearance of the pelage, makes it probable that the mouse was born in 1927 or earlier. It was trapped at Fish Lake in the Steen Mountains, southeastern Oregon. Apparently the presence of the caecum upon the back is not incompatible with a successful endurance of the relatively severe winter of this region. The mouse was neither lactating, nor pregnant, although seven out of ten females captured at the same time were noted to be either carrying or rearing a brood. The absence of any marks of maternal activity might be considered as evidence that the specimen in question was physically not quite up to par.

The position of the caecum, in the specimens of *Peromyscus* that I have examined, varies somewhat, but speaking generally it is on the right side with apex projecting caudad. The projection of this external caecum is in the opposite direction. Shortly after leaving the caecum the colon usually undergoes a triple U twist. The beginning of this twist as well as the entrance of the small intestine, at the side, were, as may be seen in the sketch, both well outside the body.

Anomalies of a grosser nature appear to be rare in *Peromyscus*. I have not previously noticed a rupture or hernia. Recently I have opened about two hundred specimens, for the purpose of removing the endocrine organs, and have found the viscera to be quite uniformly situated in their relative positions.—R. R. HUESTIS, *University of Oregon, Eugene, Oregon.*

REITHRODONTOMYS HUMULIS FROM THE TYPE LOCALITY

On March 4, 1928, E. B. Chamberlain and I were each so fortunate as to catch a specimen of the eastern harvest mouse, *Reithrodontomys humulis humulis* (Audubon and Bachman). The exact locality is a small broom-straw field surrounded by a large forest of mixed growth in a moderately low, moist area about three miles west of Drayton Station, Charleston County, South Carolina. The field has been unused for a number of years and is covered sparsely with low bushes and weeds. Both specimens were males. One was trapped in dead brush, and the other in the runway of a cotton rat (*Sigmodon h. hispidus*). In the same field, on March 10, I caught in traps placed in the runways of cotton rats an adult male and an adult female harvest mouse. A male taken March 11, however, was caught in a trap set in a mole (*Scalopus a. howelli*) burrow in such a manner that it seems unlikely that it could have been caught except as it passed through the burrow.

Since these five specimens are all from the type locality, their measurements of total length, tail, and hind foot as made in the flesh are recorded:

March 4; ♂; 114–60–15; E. B. Chamberlain; no. 28.58.1, Charleston Museum.

March 4; ♂; 117–51.5–14; R. H. Coleman; no. 39, Coleman collection.

March 10; ♀; 114–55–16; R. H. Coleman; no. 49, Coleman collection.

March 10; ♂; 121–61–17; R. H. Coleman; no. 50, Coleman collection.

March 11; ♂; 116–56–17; R. H. Coleman; no. 55, Coleman collection.—Robert H. Coleman, *4 Green Street, Charleston, South Carolina.*

AN EXTRA RIB IN A MIOCENE ARTIODACTYL FROM NEBRASKA

During the summer of 1927, a party from the Colorado Museum of Natural History, working in the Lower Miocene (Upper Harrison) beds of Sioux County, Nebraska, collected among other things a fine group of well articulated skeletons of the large short-faced merycoidodont, *Merycochoerus magnus* (Loomis). The largest of these skeletons is at present being prepared for mounting, and exhibits some interesting characters in its posterior dorsal and anterior lumbar vertebrae.

Normally this group has fourteen dorsals and six lumbars. That is true in this individual; but, while the right side is normal, on the left we find an extra, or fifteenth rib, nearly as large and strong as the fourteenth, between the last dorsal and the first lumbar. The transverse process of the first lumbar is much reduced in size on that side, and much larger and stronger on the right side, in a measure compensating for the difference between them.

The vertebrae in that region show marked evidence of a pathologic condition, notably between the twelfth and thirteenth dorsals; also, between the fourteenth dorsal and the first lumbar; and between the second and third lumbars, so that these bones are in reality ankylosed by the exostosis on their ventral surfaces. This pathologic condition is under study by Drs. F. B. Young and A. L. Cooper, who are attempting to work out and report to the American Medical Association some interesting problems in paleopathology.

While the occurrence of accessory ribs is well known, it seems worth while to record this instance in another, and fossil, family. This specimen when completed will be placed on exhibition in the group now under preparation in the Colorado Museum of Natural History, Denver, Colorado.—Harold J. Cook, *Denver, Colorado.*

RECORDS OF DASYPUS KAPPLERI AND DASYPUS PASTASAE

On one of the recent Captain Marshall Field South American expeditions of the Field Museum, Edmund Heller secured three armadillos in Peru which, doubtless, are referable to *Dasypus pastasae*. These specimens, one skin and skull, one skull only, and one skin only, were all taken at Pozuzo in January and February, 1923. This species has not been recorded since the first two were taken, much farther north, at Sarayacu, Upper Pastasa River, Oriente of Ecuador, in 1877, and described by Thomas (Ann. and Mag. Nat. Hist., ser. 7, vol. 7, p. 370, April, 1901).

The known specimens are therefore now raised to five.

Of *Dasypus kappleri*, to which *pastasae* may prove to be subspecifically related, there are but seven specimens known. The first four were taken by Doctor Kappler in Surinam about 1860, and described by Krauss (Archiv. Naturg., vol. 1, p. 24, 1862). There appears to be no other published reference to further specimens until 1921, when Anthony (Zoologica, vol. 3, no. 13, p. 270, 1921) records three from Kartabo and Kalacoon, British Guiana, collected by William Beebe.—Colin Campbell Sanborn, *Field Museum of Natural History, Chicago, Illinois.*

NOTES ON SOME FLORIDA MAMMALS

Mustela peninsulae olivacea Howell.—Writing of the Alabama weasel, Howell (North American Fauna no. 45, p. 36,) states: "Weasels are apparently scarce everywhere in the southern states and specimens are difficult to obtain." This fact makes it of interest to record a specimen that the author caught in a California pocket-gopher trap February 13, 1927, near Gainesville, Florida. Two days previously this trap had been set at an opening of a pocket gopher burrow which had been exposed by digging about a foot below the surface in a scrub oak habitat. The following morning an adult female *Geomys floridanus* was in the trap. Thinking that it might be possible to catch another *Geomys*, I reset the trap in its original position. The following morning the trap contained an adult male *Mustela peninsulae olivacea*. Its head and fore legs were in the trap and it had apparently struggled violently to free itself, as the walls of the excavation in which the trap had been set were broken down. This made it impossible to form an adequate opinion as to how the weasel had entered the trap. It was possible to follow the burrow for a distance of fifty feet or more by the mounds of earth that had been thrown out. This region was examined thoroughly for an opening by means of which the weasel might have gained access to the burrow, but none was found.

The only other record of this subspecies from Florida, of which I am aware, is an adult male taken by O. C. Van Hyning of the Florida State Museum, on the Experiment Station grounds, Gainesville, Florida, January 15, 1918. I am indebted to T. Van Hyning, director of the Florida State Museum, for permission to publish this second record, which specimen is in the collection under his charge.

Pitymys parvulus Howell.—An adult male was collected by a colored girl, July 14, 1927, at Gainesville, Florida, by hitting it squarely with a board. The lady for whom the girl was working presented the remains to the author and considering the means of capture it is a very good specimen. It was annoying or was being annoyed by some half-grown chickens when the capture was made. So far as I know, this is the second locality record for this species.

Reithrodontomys humulis merriami Allen.—An adult male was taken March 17, 1927, in a pasture near Gainesville, Florida. A. H. Howell, who identified all of the above mentioned specimens, states that this is the first typical specimen of *merriami* he has seen from Florida.—HARLEY B. SHERMAN, *University of Florida, Gainesville, Florida.*

MAMMAL NOTES FROM SULPHUR RIVER, BOWIE COUNTY, TEXAS

A trip to the vicinity of Texarkana, Bowie County, Texas, undertaken in 1928 for the purpose of working out several problems relative to the distribution of certain amphibians and reptiles, netted in addition many specimens of land and fresh-water shells and a few mammal skins. A week was spent in collecting the fauna of a series of sloughs connecting with the Sulphur River, on the boundary of Cass and Bowie counties, ten miles south of Texarkana. It was in the early part of March, the weather was cool, and it rained for the greater part of six days. Therefore collecting was unpleasant and rather unprofitable. We had one warm sunshiny day, and devoted this to the collecting of snakes and lizards, many species of which made their spring appearance at this time. On this day we collected our most interesting mammals—specimens of *Peromyscus nuttalli aureolus* (Audubon and Bachman) and *Blarina brevicauda carolinensis* (Bachman), both of which had previously been collected in Texas only by field agents of the U. S. Biological Survey; the mouse at Joaquin, Shelby County, only a few miles from the Texas-Louisiana boundary line, and the shrew at Joaquin and the Big Thicket near Sour Lake. A pair of *Peromyscus nuttalli aureolus* was found in the hollow of a large fallen tree, while two specimens of the shrew were found in burrows under small logs. The burrows of the shrew each had only two entrances, and by stopping one it was possible to easily capture the occupant. The locality where the two species were found is called "the island." It is a stretch of high land almost surrounded by the waters of the river and sloughs. During high water, this land really forms an island. The mammals were found only a few feet above high water mark.

Other mammals collected or identified were *Didelphis virginiana virginiana* Kerr, *Mustela vison mink* (Peale and Beauvois), *Procyon lotor lotor* (Linnaeus), *Sciurus niger rufiventer* (Geoffroy), *Glaucomys volans texensis* Howell, *Geomys breviceps breviceps* Baird, *Peromyscus leucopus leucopus* (Rafinesque), *Sigmodon hispidus texianus* (Audubon and Bachman), *Neotoma floridana rubida* Bangs, *Sylvilagus floridanus alacer* (Bangs), and *Sylvilagus aquaticus aquaticus* (Bachman).

A nest of the water rabbit (*Sylvilagus a. aquaticus*) containing two young, found under a long fallen branch, was lined with the light under-fur from the mother's breast.—JOHN K. STRECKER AND WALTER J. WILLIAMS, *Baylor University, Waco, Texas.*

SOME NOTES UPON UTAH MAMMALS

That *Thomomys perpallidus aureus* may give birth to more than one litter each year is shown by the following: A female trapped at Richfield, Utah, March 10, 1928 (A. W. M. no. 382), was suckling young and carried eight embryos, the sacks measuring 7 mm. in diameter. Another suckling female was trapped at the same location, in one trap of a double set, the other trap of the set containing an adult

male that was sexually active. The female upon examination showed a swollen vulva and enlarged uterus, which was not inflamed and contained a milky fluid. Uterine scars were not visible.

Mus musculus musculus was found living in the open fields in the vicinity of Richfield, Utah, five being obtained during the period March 11 to 15, 1928. These were the only ones observed by the writer following much poisoning and trapping over the state. Claude T. Barnes, author of "Utah Mammals," says that he has no such record for the state. Specimens were obtained along the edge of a grain field and more than a half-mile from any building. The sheen of their pelage contrasts greatly with that of indoor specimens of the same period and indicates that they had been living in the open for a considerable length of time. Cold stormy weather prevailed during the period mentioned, including two snowstorms. A strawstack in the vicinity yielded no specimens except *Peromyscus* and *Microtus*.

That the Zuni prairie dog (*Cynomys gunnisoni zuniensis*) is not entirely terrestrial was shown by the observation of an adult specimen sitting upon the top of a stunted sage bush, the elevation of the animal being about 18 inches above the ground. Observation was made about 2 p.m., May 18, 1928, approximately one mile north of Monticello, Utah.

An adult male *Dipodomys ordii longipes* was observed walking upon the top of its mound about 1 p.m., May 20, 1928, near what is known as Hatch Crossing, located about twenty-five miles northwest of Monticello, Utah. Partial shade was afforded from a small grease-wood bush, around the roots of which the mound had been built. Full sunlight prevailed.—A. W. Moore, *U. S. Biological Survey, Portland, Oregon.*

WALTHER FREDERICK HENNINGER

The Reverend Walther Frederick Henninger, a member of the American Society of Mammalogists, died after a long illness February 2, 1929, in Manchester, Michigan. In him the society loses an energetic, enthusiastic, and highly gifted member, who, had he recuperated from his illness, no doubt would have made valuable contributions to American mammalogy, as he was an indefatigable worker, a painstaking observer, and a discriminating reporter.

Henninger was born December 2, 1873, at Herman, Missouri, the son of the Reverend Frederick Henninger and his wife Mary *née* Lenz. He was trained in the institutions of higher learning of the Moravian Brethren in Germany, but finished his theological course in St. Louis, Missouri. After his ordination in 1894 he served congregations in the following places, all in Ohio: Jackson and South Webster, Tiffin, and finally New Bremen. Any spare time he had, or when he should have been resting and in bed, he spent in collecting and preparing birds, mammals, and insects. His knowledge in these three fields of natural history was extensive and clear. His collection of skins of Ohio mammals passed into the possession of Concordia Teachers College, River Forest, Illinois, but immediately he started to make another one.

In 1921, he, at the urgent request of his church, went to Rio Grande do Sul, Brazil, to help organize a school of higher learning for the purposes of his church in those parts. Although teaching up to capacity he wrested away some time

and strength to carry on his beloved scientific collecting, accumulating a collection of about eight hundred birds, one to two hundred large and small mammals, and thousands of insects.

Either as a result of overtaxing his strength or due to the climate, he contracted a severe heart and kidney disease, so that for weeks he hovered at death's door. Under the good care of his wife and very able physicians he recuperated enough to risk a trip to Bad Nauheim, Germany, where, according to the doctors' opinion, he was almost entirely cured, though it seemed nothing short of a miracle.

He returned to his former home in Tiffin, Ohio, in the fall of 1927, and joyfully accepted a call to a church in Manchester, Michigan. He hoped that he once more would be able to give free rein to his enormous bodily and mental powers, and to have extensive intercourse with many naturalists. When I visited him over last Thanksgiving, he especially joyfully looked forward to the Ann Arbor meeting of the Mammalogists. Alas, it was not to be. A treacherous attack of influenza brought a relapse of his former malady and on February 2 two strokes took him away without pain, though he was conscious to the last.

His family, consisting of the widow and three daughters, has lost a faithful, loving husband and father, his church an able, sincere and eloquent worker, natural science a gifted and industrious student, and his friends an unforgettable, lovable, yet forceful, sincere, and upright friend.—C. W. G. Eifrig, *River Forest, Illinois.*

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CORRESPONDENCE

PREDATORY MAMMAL CONTROL WORK OF THE U. S. BIOLOGICAL SURVEY

February 19, 1929.

Mr. Paul G. Redington, Chief,
Bureau of Biological Survey,
Washington, D. C.

Dear Mr. Redington:

I am sending you a copy of the American Society of Mammalogists Committee report on the predatory mammal problem. You have no doubt seen it in the *Journal of Mammalogy* for November, 1928.

Our Committee was about ready to report when you took charge of the Bureau, and this was a leading reason that I delayed a report at that time—to enable you to get the lay of the land before the report was presented.

I was pleased to see in your latest Annual Report of the Bureau that you stated positively that the Bureau policy was not one of *general extermination*. The next practical step is to see how this practice will be *interpreted in the field*, and furthermore what *research program* will precede practice. So far so good, but when I secured a copy of House Doc. No. 496 (70th Cong. 2nd Session) on "Control of Predatory Animals," with its request for over 10 million dollars for a ten year program, in which I see *no provision for research to guide practice*, I again wondered where are we drifting! I think that before any such program is started you should consider this with the American Society of Mammalogists, no less than with the cattle and sheep interests, stating your case, and profiting by their suggestions, unless you consider them negligible. Some of the statements in this report do not harmonize with previously published statements by the Bureau, but there are important improvements.

I think it is the duty of the Bureau to prepare a careful report outlining the real basis for its policy in relation to other control problems and to public welfare. I feel confident that the Bureau can not restore full confidence among naturalists in its policies until it makes such a report. Of course, they count for little politically, but I can not believe that they can be neglected in any sound long time policy.

I believe that you know that I have no ax to grind or I would not write you this letter. I think that I realize some of the difficulties also under which you work and my only interest is a sound constructive program. With your strong personal support of Secretary Jardine I feel that you should be able to make a substantial program and progress.

With best regards,

Very sincerely,
CHAS. C. ADAMS.

New York State Museum,
Albany, N. Y.

POLICY OF THE U. S. BIOLOGICAL SURVEY IN REGARD TO PREDATORY MAMMAL CONTROL

April 4, 1929.

Dr. Charles C. Adams,
Director, New York State Museum,
Albany, New York.

My dear Doctor Adams:

In response to your letter of February 19, the receipt of which was acknowledged on February 27, 1929:

I have studied both the report of the full committee of the American Society of Mammalogists, appointed to report on wild-life sanctuaries suitable for the preservation of predatory animals, and the supplemental report of three members of the committee, including yourself (the other two being Mr. Joseph Dixon and Mr. Edmund Heller), and note with gratification that while the supplemental report criticizes certain operations of the Biological Survey concerned with the control of injurious wild animals, the report of the full committee is essentially in harmony with the viewpoint and policies of the Bureau.

Both your committee and the Biological Survey are in accord regarding the necessity of preserving suitable areas for the continued existence in satisfactory numbers of examples of our native fauna. Extensive wilderness areas have already been established in national forests, in national parks, and elsewhere, and the tendency is to extend this form of wild-life protection through the creation of research reserves and primitive areas on the forests and wild-life sanctuaries there and elsewhere. In the long run the preservation in a natural state of considerable samples of the native fauna and flora can only be hoped for in such extensive wilderness areas and other absolute sanctuaries. In other words, in the course of time civilization and the economic production that goes with civilization will require all space except those areas that are in advance specifically reserved for wild-life conservation.

That we are all practically agreed on this point will in effect answer much of the criticism in the supplementary report above referred to. Our position will be further understood and, I believe, will be very generally indorsed, when it is made clear to all interested in wild-life conservation that our operations for the control of predatory animals and other injurious species merely hasten the inevitable elimination of various animals from areas occupied by man, a process that is defensible because of the great economic benefits that accrue. The case is somewhat comparable with that of the buffalo, which though slaughtered years ago in a disgraceful way would have had to be reduced in numbers in any event by the advance of civilization, and its numbers very probably would be no larger now than if the rapid slaughter that has been so justly criticized had never occurred.

The chief criticism contained in the supplementary report, and the one emphasized in your letter, has to do with what is considered lack of sufficient research antecedent to control operations. I am sure, however, that the feeling of those who have offered the criticism is not that the *necessity* for control of predatory animals needs to be made the subject of research, but that the material needed for studies of the various species of our wild life may disappear before opportunity can be taken to make thorough studies of their life histories. As I have just

pointed out, however, such studies in future will have to be made more and more in wildernesses and refuge areas instead of, as in the past, in places throughout the natural ranges of the species most convenient to the investigators.

A point that seemingly was insufficiently considered by those responsible for the supplementary report is that the research work of the Biological Survey not only has preceded control measures but that it is still being continued and will be conducted on an extended scale in future years. Furthermore, it is going on at present hand in hand with control operations. Experienced biologists of the Biological Survey were engaged for many years in ascertaining facts regarding the geographic distribution, relationships, habits, and destructiveness of the species affected by our control programs before these were put into effect. When the control measures were begun as a result of recognition of the fact that certain species were unduly abundant and seriously destructive, the Biological Survey continued to assemble facts to guide the control operations.

The ten-year program for the control of predatory animals, which was prepared at the request of the Congress (House Document No. 496, 70th Congress, 2d Session), has apparently been misconstrued. This is purely a control program and is separate entirely from other programs of research for which provision has been made. Research to guide practice has been continued under existing Congressional appropriations to the Biological Survey. Another measure, commonly known as the McSweeney-McNary Forestry Research Act, passed by Congress before the ten-year control program was drawn up, is intended to provide for broad policies of research affecting all types of forest-inhabiting species of wild life, including predatory animals and injurious rodents as well as the harmless and economically beneficial forms, and to supplement on an enlarged scale other funds provided for research work. Since this measure providing for research antedated that for a control program, it should be apparent that we are acting in good faith in our efforts to strengthen the research work to the utmost.

Since the control operations of the Biological Survey constitute a service program to the public, carried out in accordance with acts of Congress and the requests for assistance from many States and from thousands of farmers and ranchmen, it would not be practicable either to suspend or to discontinue them in order to await the results of further research in a separate program extending over several years. No farmer, for example, would consent to permit a predatory animal to make constant raids on his livestock while research reports were being awaited to show whether the same predator might be saving him the trouble of combating injurious rodents. Rather would he put an end to the predator and then if need be proceed to war on the rodents himself. Naturally the economic interests of the public must take precedence over the interests of injurious wildlife forms, except upon areas set aside for their perpetuation. However, the results of research will be incorporated into our practice just as rapidly as there is made available new and reliable information upon which administrative procedure can be based with reasonable assurance.

The policy of the Biological Survey as regards predatory-animal control (and rodent control as well) was clearly set forth in my annual report for the fiscal year 1928, drawn up from the statement to the field leaders of the control project, assembled at Ogden, Utah, in April of that year. This is shown to be one of

control of injurious wild life rather than one of eradication. My statement continued as follows:

> "The fact remains that the bureau must work for the eradication of certain species locally where their destructiveness is so impressive that no other policy of handling them is permissible. For example, the gray wolf and the prairie dog are so deleterious to agriculture and stock raising that their presence in some localities can not be tolerated. Other species, such as the coyote and the ground squirrel, are so prolific and occur over such wide areas that their extermination, even if desired, would be impossible. The Bureau of Biological Survey is not embarked upon a general extermination program, and the main objective is so to control the predatory animals and rodent pests as to reduce economic losses to a minimum."

A similar statement was contained in the ten-year coöperative program for the control of predatory animals (near the end of page 4, House Document No. 496, above mentioned), as follows:

> "The program of the organized coöperative campaigns has been one of suppression and control from the start, rather than one of complete eradication of species. This statement is injected to make it clear that the control operations are undertaken in the interests of man and his economic welfare whenever and wherever possible, and not thoroughly to eradicate from the country any species of animal life that adds interest to the wild, when far removed from industrial operations. In areas specifically set aside for the perpetuation of primitive conditions, such as the national parks, and in mountain fastnesses far remote from settlement and economic activities, operations for bringing predatory animals under control are not at present called for, and when needed they will be for the most part localized."

In the report that summarized the results of the Ogden, Utah, conference of our field leaders, the recommendation was made that the policy continue to be that of control, rather than eradication. The recommendation and comment are given in full, essentially as noted in my annual report above quoted, and will be found on pages 18 and 19. (Copy of the Report of Conference of Field Leaders, of my annual report for 1928, and of House Document 496 are inclosed.) From the whole statement I think there can be no occasion for doubt as to how policies affecting practice will be "interpreted in the field." These statements, now a matter of record, must certainly clarify for all time the attitude of the Biological Survey in control operations.

Before closing I feel that in justice to our work I must refer to the spirit of criticism underlying the supplementary report of your committee. Reliable facts should have been presented in support of the various contentions, particularly those in which there was a difference of opinion on the position taken by the Biological Survey. It is somewhat unfortunate for the argument of your committee that they cite as evidence the conclusions reached by one investigator of the outbreak of mice in the vicinity of Buena Vista Lake, California, in 1926–27. The more thorough and comprehensive investigations conducted by trained and responsible members of the staff of the Biological Survey and the State Department of Agriculture disclosed the utter inadequacy of the earlier findings and a lack of proper foundation for earlier deductions as to the relationship of predatory-animal control to this particular outbreak. We are sending you a copy of

the report published by the California Department of Agriculture on this subject (Monthly Bulletin, vol. 17, no. 10, pp. 538–560, October, 1928). The classic example of loose thinking in the past on the part of those inclined to criticize the procedure of the Survey is found in the charge that the Bureau was responsible through its predatory-animal control operations for an outbreak of jack rabbits in Oregon, which occurred approximately ten years before control operations were begun. Anyone familiar with the history of the West well knows that great outbreaks of jack rabbits and field mice occurred at frequent intervals many years before control operations were instituted by the Biological Survey or before, through any other agency, the wolves, coyotes, or other predatory animals or birds had been materially reduced in numbers. Other species, including prairie dogs, ground squirrels, and pocket gophers, existed in enormous numbers and tended to increase under the favorable conditions presented by the developing agriculture of the West. This situation became so serious that it proved necessary to resort to means other than natural control agencies to save the crops of the settlers and prevent serious damage to pasture ranges and forests.

Also, before closing, I desire to ask your permission to do two things: to present this letter at the meeting of the American Society of Mammalogists, in Ann Arbor, if the subject comes up for discussion there; and to have this correspondence published in the JOURNAL OF MAMMALOGY, where it can come to the attention of all who have read the reports that appeared in the November, 1928, issue. Our information indicates that we have the confidence of naturalists generally. Full publication of this discussion should aid toward the mutual understanding that is necessary to gain the confidence of all who have formed any opinion on the subject, adverse or otherwise.

The extent to which wild life will be preserved for posterity depends upon the extent of the harmonious coöperation of all interested persons and organizations. I wish to assure you and the membership of the American Society of Mammalogists, which you represent, that we welcome constructive criticism and reliable information that will be helpful in establishing sound policies in conducting control operations and in formulating long-time programs looking to the future welfare of the country, its people, and its wild-life population. We shall be glad to coöperate fully with any who are disposed to take an intelligent and fair-minded view of these problems and who are of a sufficiently practical turn of mind for their judgment to be relied upon. We have constantly sought and shall continue to seek this type of coöperation from all possible sources and, as indicated in the first part of this letter, we are endeavoring to strengthen and extend our research program so that it may yield results that will afford a sound basis for administrative policies. I appreciate your statement that your only interest is "a sound constructive program." I feel sure that the Biological Survey can work effectively with all who are so disposed. I sincerely hope that the coming years may witness harmonious, united effort on the part of all research agencies, so that comprehensive, dependable information may be obtained, and that there may be concerted action in the interest of genuine progress in keeping with advancing civilization.

Sincerely yours,
PAUL G. REDINGTON, *Chief*.

Bureau of Biological Survey,
U. S. Department of Agriculture,
Washington, D. C.

COMMENT AND NEWS

Beginning with volume 11 (1930), there will be a material increase in the size of each volume of the JOURNAL. In view of this increased cost, at the last annual meeting of the society, it was decided that the subscription price be advanced from $3.50 to $4.00. There is no change in membership dues.

A. Brazier Howell, our corresponding secretary, left Baltimore on June 6 for the Pacific coast, where he devoted six weeks to making investigations for the New York Zoölogical Society concerning the conservation of mammals. He is spending the month of August at Barro Colorado, Panama. During the latter part of the summer, therefore, he will be unable to act in a secretarial capacity and the indulgence of members who may have occasion to write to the secretary during that period is requested.

Another charter member is lost to the society in the death of Col. Ernest Lester Jones, on April 10, 1929, at Washington, D. C. Colonel Jones was born at East Orange, New Jersey, April 14, 1876, the son of Charles Hopkins and Ada Lester Jones. He was a member of the class of 1898 of Princeton University, did not graduate, but received the degree A.M. from Princeton in 1919. He was deputy commissioner of the U. S. Fish Commission from 1913 to 1915, following which until his death he was director of the U. S. Coast and Geodetic Survey. Colonel Jones was keenly interested in mammals, more particularly the larger species, and was an ardent and active conservationist. He served with the Signal Corps and the Division of Aeronautics with the A. E. F. in France and Italy during the World War, and received many decorations and honors for distinguished service.

The *Evening Star*, Washington, June 19, 1929, printed the following communication of even date from London:

> Oldfield Thomas, scientist and formerly a high official at the British Museum, died yesterday from a revolver-shot wound self inflicted. The coroner's inquest returned a verdict of suicide while of unsound mind.
>
> The inquest showed that Mr. Thomas had been much affected by the death recently of his wife and had left a note indicating that he was hopeless and utterly miserable over her loss.

Mrs. Thomas died unexpectedly in June, 1928. This loss so affected Thomas mentally that his physician warned friends in the United States that conditions were serious as long ago as last January. To these intimate friends, therefore, the news dispatch of June 19 will not have come entirely as a surprise. They, moreover, will realize, in a way others can not, that this revolver-shot removed not only the most distinguished member of our society, the zoölogist who has dominated the field of mammalogy for more than thirty years, but also a man of rare personal charm.